POWER

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The Fireman—Passing and Coming

A FEW years ago the boiler fireman or stoker had the most menial and least desirable job around a power plant.

The only man that he outranked, when he did not do that work himself, was the coal passer and ash handler.

The coal was fired with a scoop and the fires were worked by hand. It was hard, hot, dirty work and attracted few who had more than muscular qualification to offer.

Some of the men did attain to remarkable degrees of proficiency in the management of fires and the maintenance of continuous operation, but the principal requirement was to keep so many pounds of steam and two gages of water. If the fireman did not do the one he lost his job, and if he did not do the other he was liable to lose his life.

All that he had to go by was a steam gage and a water column.

The other day I stood in a large modern boiler room. It was roomy, light and spotlessly clean. The attendant wore a white uniform.

He did not handle any coal—there was no coal in sight—but on the fronts of the boilers were instruments that the ancient husky knew not of. Draft gages, steam-flow meters, CO_2 recorders, temperature recorders for the superheat, the uptake and the feed water.

The processes of combustion and heat absorption had compelled as much attention as the switching of the juice; the generation and transfer of heat had warranted as much expert observation and manipulation as the generation and distribution of current, and the instruments of precision were no longer all on the switchboard.

And the clean-cut, white-collared, intelligent young fellow in charge of it all was a well-paid graduate of a technical institute.

F. R. Low

Some Facts About the Naval Oil Leases

By PAUL WOOTON
Washington Correspondent

STRIPPED of the reactions incident to the exposure of graft, the facts that have been emphasized by the Senate investigation as to the leasing of the naval oil reserves have attracted the attention of the public, as never before, to the problem involved in the conservation of natural resources. The public has reacted in a way to prove that there is little support for the immediate development policy of former Secretary Fall. There now is concrete proof that Secretary Daniels' solicitude for the integrity of the naval reserves is the policy which an overwhelming majority of the people favor.

The tons of documentary material that have been produced or assembled by the Senate committee contain few new facts concerning the handling of the naval oil reserves, but the public has been impressed with the need to stop, look and listen as it would not have done without a certain amount of bell-ringing and whistle-tooting. One danger in the situation, however, is that the pendulum may swing back too far. To guard against just this contingency the President has appointed a technical commission. To those familiar with the naval oil situation, it is apparent that an intelligent policy can be formulated only after technical determination of some of the problems involved. This commission, which is headed by Dr. George Otis Smith, the Director of the United States Geological Survey, will study anew the needs of the Navy and determine the ways in which they may be met. Dr. Smith is peculiarly fitted for this position in that the bureau which he directs, and with which he has been connected for more than twenty years, has been the agency that has taken the most important part in the movement looking to the safeguarding of a reserve of oil fuel for the Navy.

THESE facts are presented not with the idea of justifying in any way the methods used in connection with the negotiations of the government oil leases, but to indicate that some form of leasing policy may still have to be considered as a part of our problem of national defense. The extent to which these oil fields may best be utilized is a matter for technical determination, and is now being studied by a commission of experts recently appointed by the President and headed by Dr. George Otis Smith, of the Geological Survey.

The superiority of liquid fuel for the Navy was recognized nearly twenty years ago by the Geological Survey. Sixteen years ago it went definitely on record in an attempt to bring that point of view to the attention of those responsible for naval operations. In a letter dated Feb. 24, 1908, Dr. Smith urged the Secretary of the Interior to retain in government ownership certain of the oil lands in California. The recommendation was renewed on Sept. 17, 1909, and made more specific in referring to compact areas of unappropriated oil lands. Interior Secretary Ballinger acted on the renewed recommendation and on the same date brought the Survey's suggestion to the attention of the President. He pointed out the need of legislative action "so as to provide for future demands of the Navy."

President Taft acted promptly. Ten days after Dr. Smith's letter was written, he began the withdrawing of oil lands from public entry pending a determination of policy by Congress. The first withdrawal included all the lands in naval reserves No. 1 and 2, as well as the greater part of those in No. 3. These executive withdrawals were confirmed by the act of Congress, dated June 23, 1910.

The Elk Hills reserve in California was recommended by the Geological Survey in 1912 and resulted in the creation of naval oil reserve No. 1. Later in the same year naval oil reserve No. 2 was created. Reserve No. 3, the Teapot Dome area, was created at the suggestion of the Geological Survey. The recommendation was made under date of April 21, 1915. It was approved by President Wilson on April 30, 1915.

At first the Navy was reluctant to consider the possibility of placing chief reliance on any fuel other than coal. Coal is available anywhere in the world. Oil could be had at very few places. Nevertheless the possibilities of fuel oil were being watched, as was indicated by the appointment of a liquid fuel board for studying the requirements of the the Navy in 1902. The early experience of the British with oil fuel was unsatisfactory. For several years the grand fleet had to be accompanied by some 100 tankers. The costs in that connection were high. It soon developed that storage in tankers resulted in prohibitive cost. The activity on the part of the British and the Japanese in providing oil storage at strategic points led to a demand for similar facilities for the American Navy. The expense involved is so great that Congress was slow in making these facilities possible. In the meantime the conversion to an oil basis, which at first had included only the Atlantic Fleet, was extended to all ships of the Navy. In so far as the Pacific Fleet was concerned, however, an essential was the providing of large stores of fuel oil at Pearl Harbor. With storage at that point the fleet would be in a position to proceed to Asiatic waters, conduct extensive maneuvers and be able to return to Pearl Harbor without refueling. It was this urgent demand for storage at Pearl Harbor, as well as at other strategic points, which led many naval officials to favor the exchange of oil in the ground for fuel oil in storage.

There also was objection in the Navy to the placing of reliance on an uncertain resource. In the case of the Teapot reservation, for instance, original estimates as to the amount of oil likely to be brought to the surface in that reserve varied from 135,000,000 bbl. to 500,000,000 bbl. Now that 82 wells have been drilled in the reserve, the estimates vary from 14,000,000 to 28,000,000 bbl. The fear of some naval officers was that reliance would be placed in a reserve that would

prove to be much less productive when it might be too late to develop sources of supply elsewhere. While there were conspicuous exceptions, the general feeling is said to have been that the exchange of oil in the

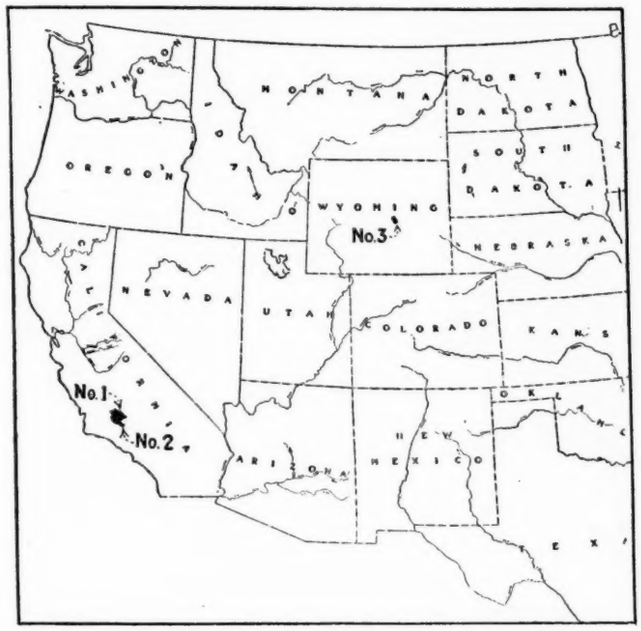


Fig. 1—Map of Western states showing location of oil leases

ground for fuel oil on the surface should be carried to the largest possible extent.

For a long time the production of such offset wells as were put down on the naval reserves were sold and the proceeds turned into the Treasury. The Navy participated in no way in those funds which, prior to the changed policy, had reached a total of nearly $6,000,000. A widely held view in the Navy was that the reserves have been created to provide the fleet with fuel oil, but instead this oil was being sold and the money turned into the Treasury while the Navy was buying oil. On March 5, 1920, Secretary Daniels wrote the chairman of the House Naval Committee concerning drainage, saying: "It therefore becomes imperative, when viewed from an economic standpoint only, that machinery be provided whereby wells may be drilled for protection against drainage from adjacent lands, or to supply oil for the government's needs." Pursuant to these representations Congress, under the act of June 4, 1920, directed the Navy to take possession of the lands and gave it wide powers to exchange and store oil at the discretion of the Secretary of the Navy. The language used in the act is unusually broad. The discussion in Congress during the consideration of the legislation shows the intent unquestionably to have been to allow the Navy to make use of such of the oil in the reserves as might be deemed proper by the Secretary of the Navy. It put the Secretary of the Navy in a position where it would not have been the logical thing to go to Congress and ask for money to buy fuel oil when he was at the same time selling oil from wells being operated under the Navy's direction.

Storage Tanks Involved in Exchange

There is difference of opinion as to the interpretation of "conserve, exchange and store"—words that appear in the act. No one has questioned the trading of crude oil in the field for gasoline in five-gallon cans. No one has suggested that the container should have been purchased with money specially appropriated by Congress for that purpose. In the same way there has been no question raised as to the exchange of crude oil for lubricating oil in steel barrels, but a question is raised as to the exchange of crude oil for containers when the container happens to be the more expensive unit represented by large storage tanks. In defense of its policy naval officers say that the tank is the container commonly used in the delivery of fuel oil. In like manner it was the view that the oil taken from the reserves could be exchanged for the facilities necessary to fill and empty the tanks. It has been stated that the exchange went to the point of including land and buildings. This is not the case. All the exchanges were limited to fuel oil and the facilities incident to its storage.

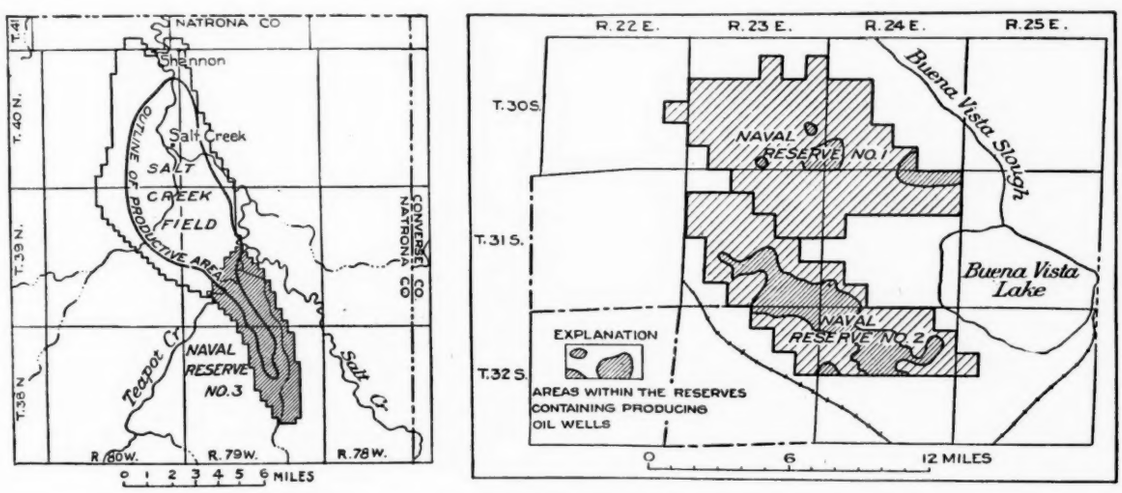


Fig. 2—Plat of Naval oil reserves indicating location of oil producing wells

When the naval reserves were created, it was thought that the private holdings within the reserve could be disposed of without difficulty. By 1920, however, a number of these claims had been the subject of court action and it was apparent that in the bona fide cases

the holders could not be dislodged from their equity. This injected great uncertainty into the situation, as the holders of those claims could undertake operations, and in some cases serious drainage was threatened. The proportion of bona fide claims on the reserves never has been determined accurately. It is well understood however, that a large percentage of the private claims were not founded on actual rights. In that connection sight must not be lost of the fact that Congress failed to provide either the legislation or the appropriations necessary to deal with private claims on the reserves.

On the No. 2 reserve only 15 per cent of the area originally set aside finally proved to be Navy land; that is the remaining 85 per cent was adjudged as belonging to persons who had staked claims. On the No. 1 reserve, while the proportion of Navy land was much larger, it was found that 30 per cent of the Elk Hills structure, the area where drainage possibilities were great, was in private ownership. On the No. 2 reserve the drainage was so great that there is general agreement that oil could not have been held in the ground. In the case of the No. 1 reserve it was evident that some leasing or drilling by the Navy had to be done. The only difference of opinion was the extent to which it would be necessary to resort to leasing to protect the government's interest.

Lessor to Settle Private Claims

One of the provisions of the Sinclair lease was that the company must settle these private claims. It is understood that Mr. Sinclair has bought the claims of practically all the claimants. These included four claims in the heart of the Dome reserve on which it seems probable that rights could be established. If, as a result of the suit recently filed by the government's counsel, the courts should set side as illegal the Sinclair lease, the problem presented by the private claims will be returned to the lap of the government with the additional complications that are involved in the Sinclair settlements.

Another objective that was sought in connection with the Sinclair lease was the bringing of a new buyer into the territory. The Interior Department was not satisfied with the price it was receiving for royalty oil in Wyoming. The only way to get a pipe line into the territory was to lease enough ground to justify the lessor in furnishing the $27,000,000 necessary to the construction of the pipe line. A very considerable flow of oil would be required to justify so large an expenditure. The result was immediately apparent, as in 1923 the Interior Department turned into the Treasury $3,009,000 as premiums above the market price for the oil which it received from a series of contracts. During the same year the Navy received 41 cents more per barrel for its oil than did other producers in the same district.

Some Provisions of the Doheny Lease

Under the Doheny contract the Navy secured free pipe-line transportation and storage of 1,000,000 bbl. of oil at San Pedro. In addition, there was provision for bunkering, the maintenance of a three-million-barrel reserve of fuel oil on the Atlantic Coast, a 10 per cent discount on purchases of petroleum products, and the immediate building and filling of $15,000,000 worth of storage at points to be specified by the Navy. The Navy reserved the right to call for competitive bids for the construction of any of these tanks. These facilities were to be paid for when the oil would be produced on the naval reserve. In the case of the Sinclair contract, tanks to the value of $1,000,000 were to be constructed immediately and filled. Additional tanks and storage were to be constructed as accruing royalties warranted.

One of the first pronouncements of Curtis D. Wilbur, the new Secretary of the Navy, was that no further leases will be made on naval oil reserves until expressly authorized by Congress, unless it should be shown to the personal satisfaction of Secretary Wilbur that a lease is absolutely essential to prevent the draining of Navy oil. In addition he specifies that no lease will be made without competitive bidding.

Leasing Policies Contrasted

While the policy of the Administration with regard to the future handling of the oil reserves will depend to a certain extent on the recommendations of the Commission of Experts, Secretary Wilbur's statement is of significance in that it reflects the existing policy of the Administration. The policy not only reverses that of Secretary Fall, but also that of his predecessor, Secretary Payne. Important leases had been negotiated in reserve No. 2 by the preceding Administration. This is set forth concisely in the Navy Department's official reply to House Resolution 204. The House inquired if Secretary Daniels had approved leasing without public advertisement and the drilling of new wells on the naval oil reserves. The reply was as follows:

Under date of Aug. 21, 1920, the then Secretary of the Navy (Mr. Daniels) informed the then Secretary of the Interior (Mr. Payne) that the lease to the Boston Pacific Oil Co. covering the drilling of five new wells, on Section 32 of Naval Petroleum Reserve No. 2, was satisfactory to the Navy Department. The correspondence shows that the terms of this lease were agreed upon in conference between the representatives of the oil company and of the Navy Department, and that such new drilling was considered necessary because of drainage by owners of contiguous territory. The royalty accruing to the government under this lease was 25 per cent. Under the so-called Doheny lease of Dec. 11, 1922, the royalty runs from 12½ per cent to 35 per cent and the actual net royalty received has amounted to 27.14 per cent.

Under date of Jan. 25, 1921, the then Secretary of the Navy indicated to the then Secretary of the Interior his willingness to lease 120 acres in the eastern part of Section 23 of Naval Oil Reserves No. 2 to the Consolidated Mutual Oil Co., and this land was leased without restriction as to the number of wells that might be drilled. The correspondence shows that the reason for the leasing of this land was because of water conditions. The government royalty provided under this lease was from 12½ per cent to 25 per cent, while the royalty provided by the so-called Doheny lease of Dec. 11, 1922 on Naval Oil Reserve No. 1 is from 12½ per cent to 35 per cent, and the actual net royalty so far received is 27.14 per cent.

Other points of fact brought out in the reply to the House resolution follow:

Under its contract with the Mammoth Oil Co., the Navy received for its royalty oil Midcontinent prices. Actual receipts were higher by 41 cents per barrel than the selling price of other producers in the Salt Creek District.

The average royalty actually received from the Teapot Dome leases has been about 17 per cent. These Teapot Dome royalties are on what is known as the sliding-scale basis; that is to say, the royalty rate increases if wells of large production are obtained.

If the wells are small, less royalty is paid. Had the average production of wells in Teapot Dome been as anticipated at the time the reserve was leased, royalties accruing to the government under the terms of that lease would have been higher than the ordinary government rate in the adjacent Salt Creek District, and the Teapot Dome royalty was obtained on territory a large part of which was unproved.

The contracts made with the Pan American Petroleum & Transport Co. provide: Storage facilities in Hawaii for 4,200,000 bbl. of fuel oil and other petroleum products without profit to the company; royalties of from 12½ per cent to 35 per cent; acceptance of royalty oil in the field, the company bearing transportation charges to the refineries; maintenance in storage on the West coast of 1,000,000 bbl. of fuel oil for issue to the Navy at cost; supplying to the Navy of fuel oil and other products at 10 per cent less than the market price at the time of delivery; maintenance on the Atlantic seaboard of 3,000,000 bbl. of fuel oil available for issue to the Navy.

The contracts with the Pan American Petroleum & Transport Co. specifically exempt from drilling, except by the consent of the government, nearly all of Reserve No. 1, lying to the westward of the range line between ranges 23 and 24. This restriction was included in the contract in the belief that this area was less subject to immediate drainage than the other portions of the reserve. It was provided in the contract, however, that should this body of oil-bearing land become subject to immediate drainage, such defensive drilling as the government might direct could be undertaken immediately.

In his letter Secretary Wilbur declares that "both Reserve No. 1 and No. 3 contain large quantities of oil that can be preserved in the ground, at least for the present," and that "Reserve No. 2 presents a different situation by reason of the leases to the Honolulu Oil Co." The Honolulu Oil Co. claims title to 17 quarter-sections, some two thousand acres, in Reserve No. 2. Secretary Payne conducted a public hearing and ruled that the company was not entitled to a patent. Secretary Fall gave the company a lease covering the entire tract.

Among the other interesting statements in Secretary Wilbur's letter are the following:

> With reference to the drilling of offset wells we will submit to the Commission (that headed by Dr. Smith) studying the situation, the question as to whether or not contracts awarding the government a portion of the oil drained from our reserves and flowing from wells upon adjacent property cannot be arranged for based upon the consideration not to drill such offset wells, in lieu of the drilling of such wells and the consequent additional drain upon the oil reserves.
>
> The Navy Department has a comprehensive plan for oil tanks at strategic points. This plan was drawn up by the War Plans Division and has been approved by the General Board. With slight modifications it is the same as adopted in 1919.
>
> At this time the Navy Department has 4,160,000 bbl. of oil tankage complete and filled with oil. In addition, there are at Portsmouth, N. H., 300,000 bbl. of tankage being constructed under the Mammoth oil lease, which is approximately 95 per cent complete, and 2,630,000 bbl. of tankage at Pearl Harbor being constructed under the Pan American contracts, which is approximately 70 per cent complete. None of this uncompleted tankage contains oil, but the leasors are at present continuing work on both projects. Oil now being produced in the territory covered by the leases in litigation is being controlled by the receivers under order of the Court.
>
> During the pendency of the litigation, with the assistance of the Presidential commission, the Department will work out plans for the future control and management of the oil reserves, for the storage of oil supplemental to the plans already made.

The commission is prepared to push its study rapidly. Its report is expected to be of unusual importance for two reasons. In the first place, its members are peculiarly fitted to recommend a proper conservation policy. From its technical finding it will be possible, it is expected, to be able to judge with great definiteness just how far good judgment has been exceeded in the leases that have been made.

Limitations of Manual Controllers for Electric Motors

By H. D. JAMES
Manager, Control Engineering Department, Westinghouse Electric & Manufacturing Company

MANUAL controllers may be divided into four general classes—faceplate, compression, drum and cam types. In the faceplate types a series of stationary contacts are mounted on an insulated base and one or more brushes rotated around a central shaft. The brushes make electric contact with one or more rows of contacts. In some of these types the contact arm is moved directly, while in others a handle projects from the top of the controller and actuates the brush arms by means of a pinion and gear segment, so that a relatively small motion of the handle is multiplied into a larger motion of the brushes. In some of the faceplate controllers the stationary contacts are made removable from the face without disturbing the electrical connection. The resistor is mounted in the controller frame, back of the faceplate, the whole forming a self-contained unit.

A controller of the compression type is shown in Fig. 1. Instead of having a number of contact segments connected to taps on the resistor, columns of graphite disks *D* are used, the change in resistance being obtained by varying the pressure between the disks by lever *L*. This form of resistor is shown in greater detail in Fig. 2.

Faceplate and compression controllers have the resistor self-contained with the switching mechanism, whereas the drum and cam types usually have separately mounted resistors. The drum and cam types may have either rotating or lever handles, but the first two types are always provided with lever handles. The four types are representative of many controllers now in successful operation. Other forms of controllers are being built, and from time to time improvements will be made, but at the present state of the art the types referred to represent the various principles of control which are used in all manual controllers. (See articles, "Operation and

Care of Drum-Type Manual Controllers," page 368, March 4, and "Operation and Care of Cam-Type Manual Controllers for Electric Motors," page 480, March 25 issues.)

The advantages and limitations of manual controllers depend to a large degree upon the size and application requirements. The following list of advantages and limitations should be interpreted broadly, as there are many applications for manual controllers that would not justify the use of contactor control.

The advantages of a manual controller compared with magnetic are:

1. The first cost is less.

2. The space occupied by the controller is usually less and the weight is less. In some applications the weight and space requirements are often a determining factor.

3. Simplicity. Manual controllers have no electric interlocks or magnetic coils, so the wiring connections can be easily followed.

4. Manual controllers are readily inclosed to protect them against dust, dirt and moisture. Drum and cam controllers are often made watertight for use on shipboard.

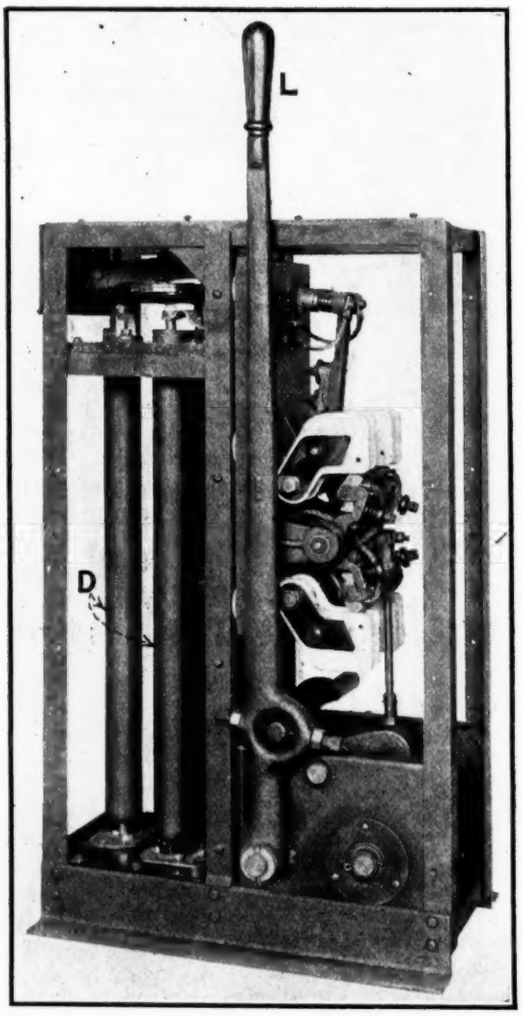


Fig. 1—Compression-type controller with the protecting cover removed

The motor circuit is opened and closed by means of a cam-type contactor, shown at the right. The carbon pile resistor is shown at *D*.

The limitations of the manual controller compared with the magnetic control are:

1. The larger sizes of control require more effort to operate and may tire the operator if used frequently.

2. The contacts will wear more rapidly, as their operation is not as positive. The more quickly the contacts are opened and closed the less will be the maintenance.

3. The arcing takes place near the operator. This is not objectionable for small controllers, but it is safer to have the main arc rupturing parts located remote from the operator where a considerable amount of power is being handled.

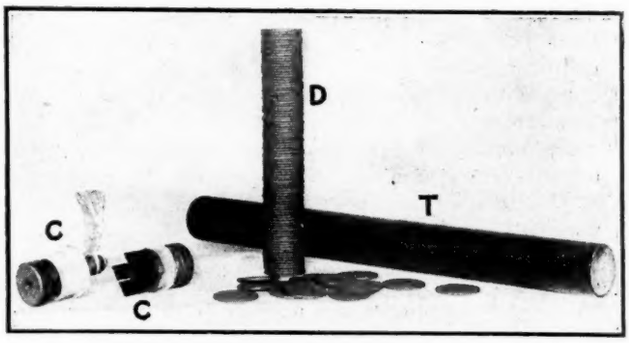


Fig. 2—Shows the construction of the resistors used in Fig. 1

The resistors are composed of graphite disks *D* inclosed in a metal tube *T*, insulated on the inside. Contact is made at each end of the pile by disks *C*. The resistance is changed by varying the pressure between the ends of the pile.

4. The larger-sized manual controllers occupy more space than the master switch of the magnetic type and, therefore, on cranes and other applications large manual controllers may interfere with the operator's seeing his work.

5. A separate protective panel is required for manual controllers to obtain overload and low-voltage protection. Many applications require the use of these panels. Some types of watertight controllers have the protective panel mounted in the same case as the master control.

In rupturing the arc, ionized gases are produced which must be removed by ventilation. Where the controller is inclosed, the air space surrounding the arc-rupturing parts is limited and the ventilation poor. Where the circuit is opened and closed frequently, trouble may result due to the accumulation of these gases. This difficulty is not so likely to occur with small controllers and may be avoided by ventilating the inclosing cover of the larger sizes. The more quickly the arc is ruptured the less gas will be produced. When a controller is inclosed, the arcing heats the air space within the inclosure and may limit the current-carrying capacity of the contacts and other parts. Manual controllers are usually rated for either intermittent or continuous duty. Continuous service presupposes only a small amount of arc rupturing. Intermittent service must assume a certain amount of heat being generated by the arc. The more frequently the circuit is opened the less time the current-carrying parts will be in circuit, and, therefore, the increase in air temperature inside the inclosure due to arcing will be counterbalanced by a smaller loss of energy due to the heating of the current-carrying parts; usually, the rating increases for intermittent duty.

Finding the Flywheel Weight Required by an Internal-Combustion Engine

By P. H. Schweitzer

The calculation for the weight of flywheel necessary for an internal-combustion engine of a given horsepower and type involves considerable labor. In the absence of some chart such as herewith shown, the engineer has been forced to go through the entire process each time an engine or engine drive has been laid out.

In this chart the factor of fluctuation K is shown for a number of typical drives, and the engineer can easily determine to what particular type his driven machine belongs. Full instructions as to the steps to be followed when using the chart are given in the illustration.

Attention is called to the allowance that must be made when the engine is burning producer or blast-furnace gas. With such fuels the upper point adjacent to the particular combination of cylinders should be the point from which the line to the brake horsepower is drawn.

The term "constant engine" is intended to embrace all those types wherein the fuel is burned at fairly constant pressure, including the air-injection Diesel and those solid-injection oil engines where the combustion, while partly at constant volume, is mainly at constant pressure. The explosion engines include all units using a gaseous or vaporous fuel and semi-Diesel engines operating on the Otto cycle.

As noted on the chart, the flywheel weight W is assumed to be centered in the rim. The weight of the arms and hub, of course, influence the WD^2 and a deduction of about $0.1W$ should be made for them. It will be found that the actual weight of rim, hub and arms will amount to about 1,5 the weight W found from the chart.

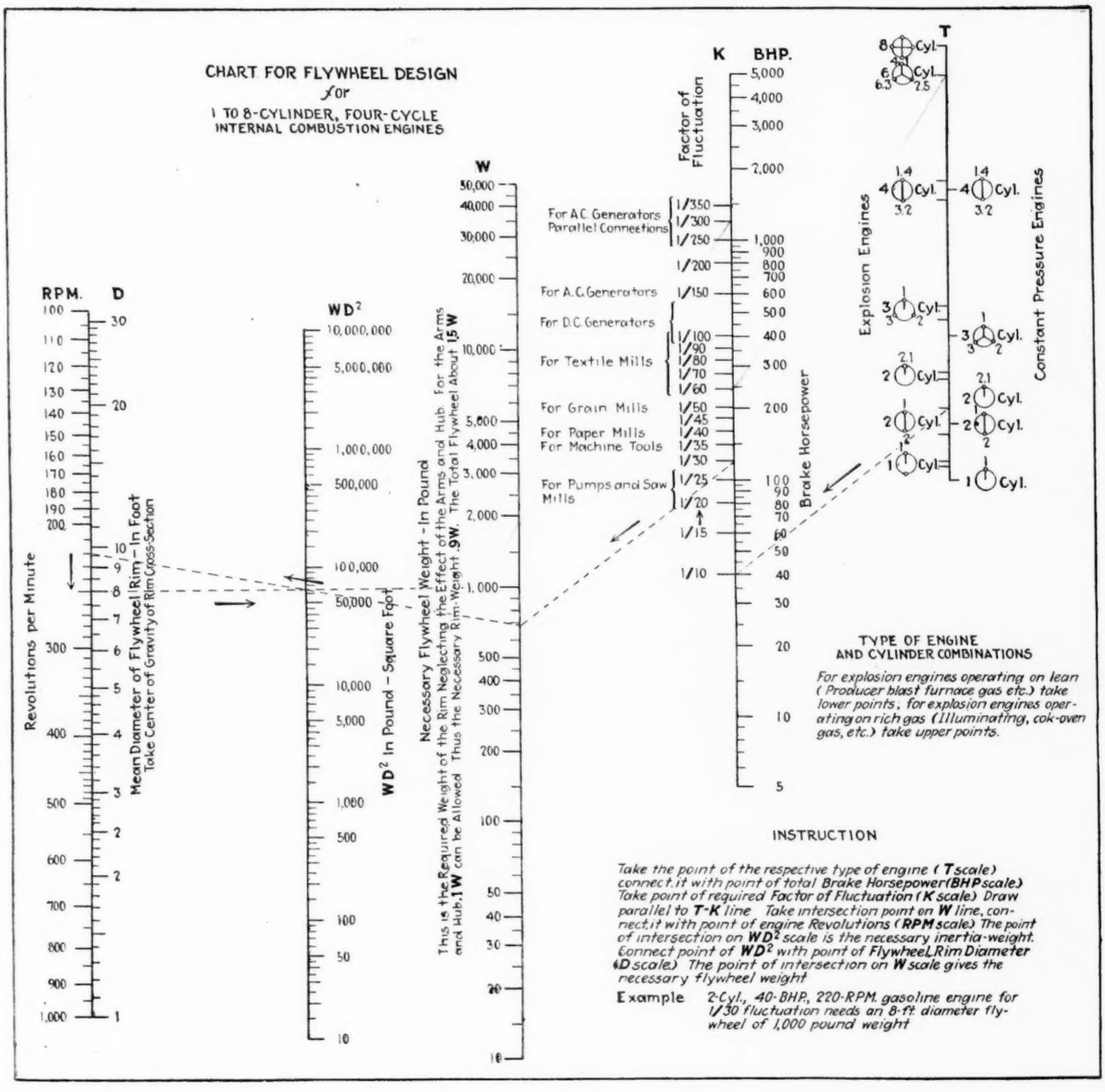


CHART FOR FLYWHEEL DESIGN
for
1 TO 8-CYLINDER, FOUR-CYCLE
INTERNAL COMBUSTION ENGINES
RPM.
D
WD²
W
K
BHP.
Revolutions per Minute
Mean Diameter of Flywheel Rim – In Foot
Take Center of Gravity of Rim Cross-Section
WD² In Pound – Square Foot
Necessary Flywheel Weight – In Pound
This is the Required Weight of the Rim Neglecting the Effect of the Arms and Hub. For the Arms and Hub 1W can be Allowed. Thus the Necessary Rim Weight .9W. The Total Flywheel About 1.5W
Factor of Fluctuation
For A.C. Generators Parallel Connections
For A.C. Generators
For D.C. Generators
For Textile Mills
For Grain Mills
For Paper Mills
For Machine Tools
For Pumps and Saw Mills
Brake Horsepower
T
Explosion Engines
Constant Pressure Engines
TYPE OF ENGINE AND CYLINDER COMBINATIONS
For explosion engines operating on lean (Producer blast furnace gas etc.) take lower points, for explosion engines operating on rich gas (Illuminating, cok-oven gas, etc.) take upper points.
INSTRUCTION
Take the point of the respective type of engine (T scale) connect it with point of total Brake Horsepower (BHP scale) Take point of required Factor of Fluctuation (K scale) Draw parallel to T-K line Take intersection point on W line, connect it with point of engine Revolutions (RPM scale) The point of intersection on WD² scale is the necessary inertia-weight. Connect point of WD² with point of Flywheel Rim Diameter (D scale) The point of intersection on W scale gives the necessary flywheel weight
Example 2-Cyl., 40-BHP., 220-RPM. gasoline engine for 1/30 fluctuation needs an 8-ft. diameter flywheel of 1,000 pound weight

Heat Balance in Devon Station*

Heat Cycle Designed for Steam Plant That Operates in Parallel with Hydro-Electric Stations — Steam Plant May Supply Either Base- or Peak-Load Power

VARIOUS factors entered into the selection of the particular heat cycle chosen for Devon station. The first in order of importance was reliability. The designers endeavored to provide all reasonable safeguards to the continuity of the operation of the plant. The second object was to obtain the most economical arrangement when taking into consideration the operating cost, the first cost or investment required, and the particular load conditions of the station. Owing to the fact that this plant will operate in conjunction with a hydraulic development, it has various types of services to perform throughout the year; that is, during certain periods it will operate on a relatively high load factor and at other periods on a relatively low load factor. The changing character of service had a very large bearing on the amount of investment that could be made in order to obtain economy of operation. Provision had also to be made to take care of the future when an increasing system load will give this station a better yearly load factor and in that way justify additional economy devices. Simplicity and flexibility for the convenience of the operators were striven for. An arrangement that is readily understandable and easily manipulated by the operators makes for both reliability and economy in the daily operation and in the maintenance of the plant. By reason of the rapid development that has been made in power station design in the last five years and the radical departures that have taken place in this period, it was necessary to make the design as flexible as possible, so as to take advantage of future advances in the art.

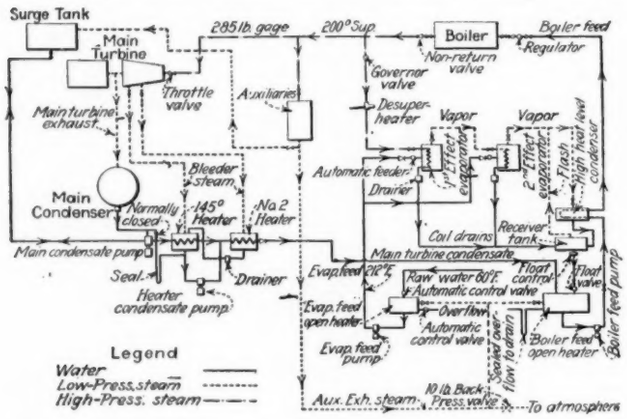


Fig. 1—Simplified diagram of high- and low-pressure steam and water piping

The type of drive to be used for station auxiliaries and the method used for heating the feed water are so intimately tied together that it is necessary to treat two subjects as one. The methods in use at the present time fall into five general classes.

The first method is to have all auxiliaries steam driven and utilize the exhaust steam for heating the feed water. This plan has the merit of being absolutely reliable and of safeguarding the auxiliary drive from line disturbances, but it is impossible to apportion the quantity of exhaust steam to the heat required for feed-water heating. The small turbines driving the auxiliaries are not so efficient as the main turbine, and a loss in economy results.

The second plan is using a combination of steam-driven and motor-driven auxiliaries and has been popular for a number of years. With this scheme essential auxiliaries can be steam driven and the number proportioned to the quantity of exhaust steam required. This system is reliable and has flexibility, but the economy is not equal to that of the motor drive.

The third general plan is to use all electrically driven auxiliaries. This is the most economical, as the efficiency of the main unit is utilized in generating the energy for station power. In order to use this plan, it is necessary to meet the other two requirements—safeguarding the station service against interruption and heating the feed water. To meet the requirements the use of the house turbine came into vogue, the essential auxiliaries being connected to the house-turbine bus. The condensate from the main unit is used as the cooling medium in the house turbine condenser. The load can be varied on the house turbine, so that it supplies just sufficient steam to heat the feed water to the predetermined temperature. In case of line disturbance the house-turbine bus or emergency bus disconnects from the station-service bus and the house turbine carries all the essential auxiliary load. The house turbine is, of course, more efficient than the small individual auxiliary turbines, but still not so efficient as the main unit.

The next step in the art was the adoption of the regenerative cycle on the main unit or the heating of that portion of the boiler-feed water obtained by the use of the condensate in successive steps by bleeding steam from the main unit. As all the heat required for heating the boiler-feed water can be obtained from bleeding the main unit, all auxiliaries can be electrically driven. A plan that has been adopted for one or two of the stations now being designed, is to supply the auxiliary power from a shaft-end house generator. This arrangement, while giving theoretically an efficient use of the steam for heating the boiler-feed water and a reliable source of supply for the auxiliaries, has the disadvantage of increasing the length of the main generating units, makes it undesirable to install a shaft-end exciter, and may, therefore, require the use of a separately driven exciting unit. The scheme also requires an outside source of power to start up the plant if the boiler-room auxiliaries are all motor driven. The plan adopted for the Devon station includes the use of the regenerative cycle, with two-stage bleeding from the main units with electric-driven auxiliaries protected by a separate emergency turbine.

Under the steam conditions of the Devon station (300

*Described in March 25 issue, page 474.

lb. gage and 200 deg. F. superheat) this cycle for two-stage bleeding has an efficiency of 36.75 per cent, compared to the Rankine-cycle efficiency of 33 per cent. An infinite number of bleeder stages would approach Carnot-cycle efficiency. By this method the efficiency of the heat cycle is raised 3.75 points and auxiliaries are driven with motors that obtain their energy from the main unit. In order to safeguard the operation of the essential auxiliaries, an emergency turbine generator of 1,000 kw. capacity has been installed.

Two house service buses are installed, one fed from the main bus through the house-service transformer banks and the other by the emergency turbo-generator. These two buses are tied together by an overload switch. Any auxiliary can be switched to either bus. The condenser auxiliaries will be operated on the emergency bus. The emergency turbine in ordinary operation does not carry load; its generator floats on the line, serving as a synchronous condenser on the house service load. The rotor of the turbine runs in a vacuum that is obtained by having the exhaust connected by a 4-in. pipe to the main condenser. It is advisable to rotate the turbine wheel in a vacuum so as to save the steam that would otherwise be required to cool it and to decrease the horsepower required to rotate it.

In case of an interruption the house generator would slow down, thereby opening the governor on the turbine end. The unit would then tend to take the whole service load, the overloaded switch between the two service buses would open up, leaving the emergency turbine supplying only the emergency bus and the essential auxiliaries connected to that bus. The other two essential auxiliaries are the exciter and the boiler-feed pumps.

Turbine-driven boiler-feed pumps are installed, both for reliability and for ease of regulating. Shaft-end exciters are used. Two motor-generator sets are installed to supply direct current for the forced-draft fans and the stoker and clinker grinder motors. One of these sets is a reserve for the other and also serves as a reserve exciter.

The condensate is pumped through the two bleeder heaters to an open-feed water metering heater, Fig. 1, which also takes the exhaust from the boiler-feed pumps and evaporator drains and serves as a boiler-feed pump suction tank. The drain from the second bleeder heater is drained to the first-stage heater. The combined drains are then pumped into the condensate line between the bleeder heaters. There is an emergency water leg from the low, or first stage, bleeder heater to the main condenser. Surge tanks are floated on the condensate line ahead of the bleeder heaters. The surge tanks were located at this point in the system, so as to store the condensate before it had been heated. The bleed points are at 3.2 and 16 lb. absolute when the turbine is operating at its most efficient point.

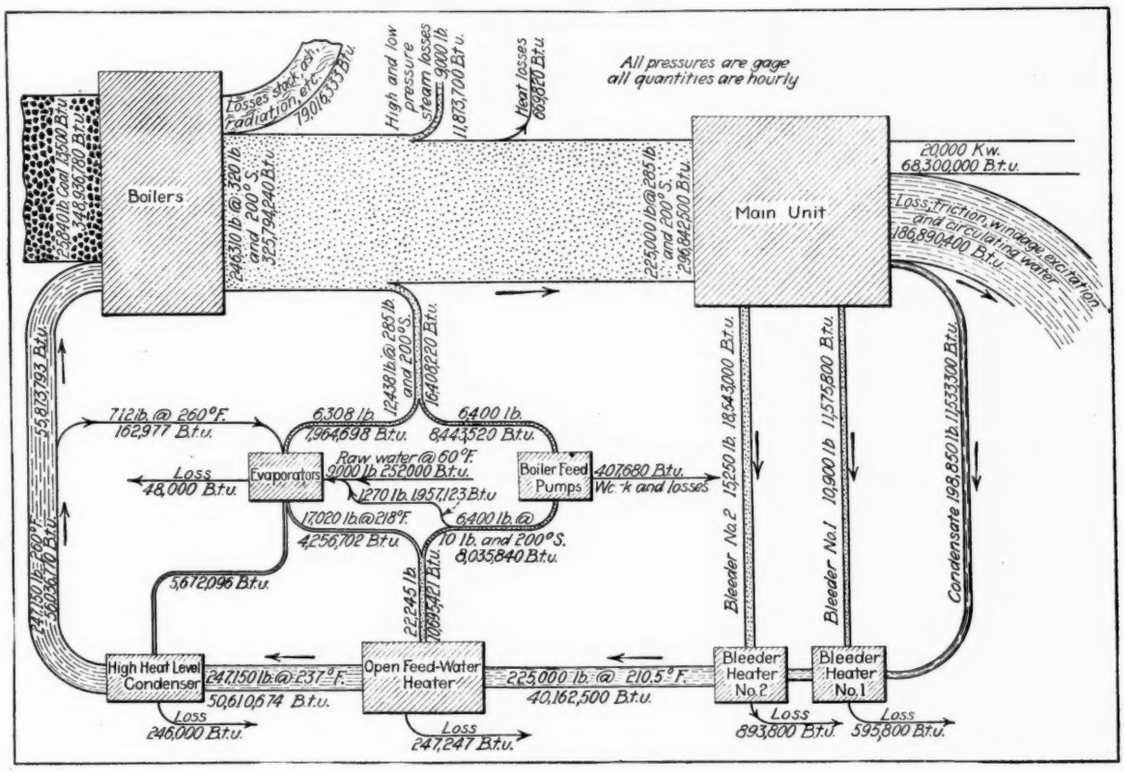

All pressures are gage
all quantities are hourly
Boilers
Losses stack, rad., etc. 79,016,333 B.t.u.
High and low pressure steam losses 9,000 lb. 11,873,700 B.t.u.
Heat losses 883,220 B.t.u.
246,310 lb. @ 320 lb. and 200° S. 325,794,240 B.t.u.
225,000 lb. @ 285 lb. and 200° S. 296,842,500 B.t.u.
Main Unit
20,000 Kw. 68,300,000 B.t.u.
Loss; friction, windage, excitation and circulating water 186,890,400 B.t.u.
12,438 lb. @ 285 lb. and 200° S. 16,408,220 B.t.u.
55,873,793 B.t.u.
712 lb. @ 260° F. 162,977 B.t.u.
6,308 lb. 7,964,698 B.t.u.
6,400 lb. 8,443,520 B.t.u.
Raw water @ 60° F. 9,000 lb. 252,000 B.t.u.
Loss 48,000 B.t.u.
Evaporators
Boiler Feed Pumps
407,680 B.t.u. Work and losses
1,270 lb. 1,957,123 B.t.u.
6,400 lb. @ 10 lb. and 200° S. 8,035,840 B.t.u.
17,020 lb. @ 218° F. 4,256,702 B.t.u.
5,612,096 B.t.u.
22,245 lb. 28,089,421 B.t.u.
Bleeder No. 2 15,250 lb. 18,543,000 B.t.u.
Bleeder No. 1 10,900 lb. 11,575,800 B.t.u.
Condensate 198,850 lb. 11,533,300 B.t.u.
247,150 lb. @ 260° F. 56,036,710 B.t.u.
High Heat Level Condenser
247,150 lb. @ 237° F. 50,610,574 B.t.u.
Open Feed-Water Heater
225,000 lb. @ 210.5° F. 40,162,500 B.t.u.
Bleeder Heater No. 2
Bleeder Heater No. 1
Loss 246,000 B.t.u.
Loss 247,241 B.t.u.
Loss 893,600 B.t.u.
Loss 595,800 B.t.u.

Fig. 2—Heat-balance diagram showing B.t.u. distribution

High heat-level evaporators are installed taking live steam. The evaporators are arranged in two effects; that is, the vaporized raw water from the first effect serves as the heating medium in the second effect, evaporating the rest of the raw water. The vapor from the second effect is condensed in the high heat-level condenser, which has the boiler-feed pumps discharging through it. The drains from the two effects and the condenser are discharged to the plant open heater. Raw water, before entering the evaporator shells, is heated in an evaporator open heater by the exhaust from the boiler-feed pumps. Fig. 2 is a heat-balance diagram showing the distribution of heat throughout the cycle.

Centralized Combustion Control in Lowellville

By JOSEPH F. SHADGEN*

One of the First Complete Remote-Machine-Regulated Combustion Systems in Large Power Plants—Fuel Efficiency Main Object—Pneumatic Dispatch System of Master Controller and Individual Regulators—Novel Central-Control House with Unique Instrument Board

THE constantly growing demand for electric current caused mainly by the steadily developing steel-making and steel-fabricating industry of Newcastle and Youngstown put the Pennsylvania-Ohio Electric Light & Power Co., which supplies that district, in a position where it became necessary to increase the actual generating capacity without delay. At the same time it was important to continue the use of the cheap fuel available in the local market.

In order to tide over the period of construction of the 300,000-kw. superpower plant on the Ohio River at Toronto (Ohio) of which the first 60,000-kw. section is now in course of construction, the main generating plant of Lowellville had to be modernized so as to produce at all times its full rated capacity of 60,000 kw. The scarcity of cooling water for condensing purposes forbade all extensions of that plant as of the others located in the Mahoning Valley.

Stevens & Wood, Inc., engineers, were retained early in 1923 for the management and operation of the public-utility properties of the district. After careful study and thorough survey they decided to increase the steaming capacity of the existing plant equipment and to improve the fuel efficiency of its boilers by adopting stoker tuyeres of improved design and by installing a complete centralized combustion-control system.

The entire layout, which is now in successful operation, is the result of original ideas on combustion and plant organization. The detailed apparatus is substantially the same as that developed during the last five years by the regulator designers while doing experi-

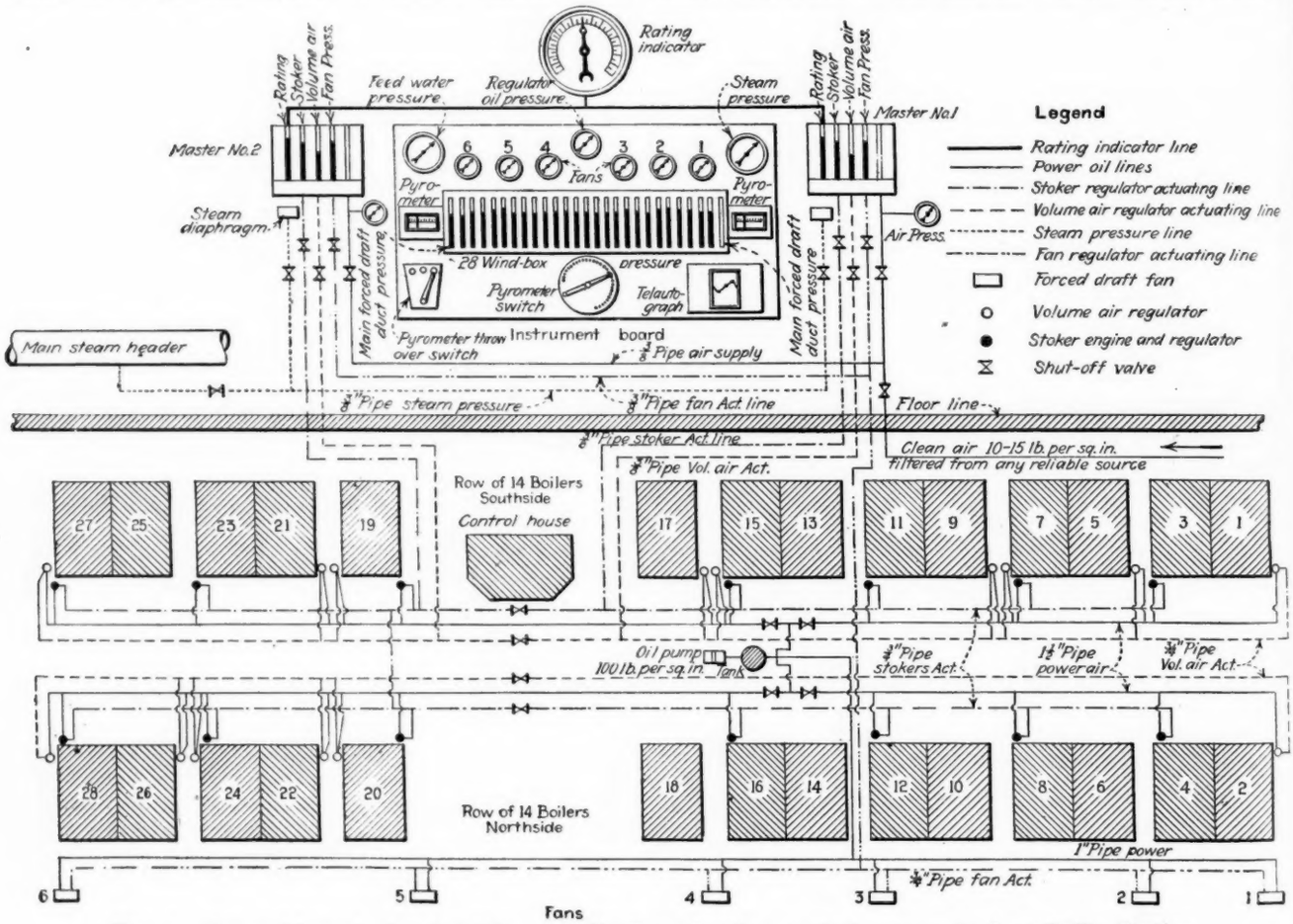


Fig. 1—General layout of automatic centralized combustion control system in Lowellville Station.

*With Stevens & Wood, Inc., Engineers.

mental work in several leading public-utility power plants in New York City, where somewhat similar systems are now in course of construction. The arrangement used has solved the problem of high efficiency under all load conditions, regardless of the labor situation.

Just outside of Youngstown with its bristling smokestacks and busy steel mills, some twelve miles down the Mahoning River, is the Lowellville power house, practically saddled on two states—Pennsylvania and Ohio—as the state line divides its coalyard. Built between 1912 and 1921 by successive additions, it comprises a brick building that houses the complete plant under one roof, with a web of transmission lines radiating in all directions. Its turbine room contains two 7,500-kw. turbo-generators and three 15,000-kw. units in a lofty, clean and well-ventilated hall flanked on the river side by the electrical auxiliary basement and floors and on the north by the boiler room. The steam is supplied by 28 boilers, in two rows of 14 each, with 6,000 sq.ft. of heating surface per boiler. The construction is of the standard water-tube type, with three drums, and with superheaters between the first and second passes. Normal steam pressure at the turbine inlet is 190 to 192 lb., while the superheat ranges between 100 and 125 deg. The safety valves are set to pop at 210 lb. to allow for the drop through the superheaters and headers.

Boiler-Room Operating Conditions

Each boiler is equipped with a 7-retort underfeed stoker. Of these 18 have hand-operated ash dumps and 10 have steam-cylinder-operated dumps. The 28 stokers are divided in 14 groups of two each, each group being driven by a single-cylinder steam engine. Each boiler is equipped with a pressure gage, an indicating steam-flow meter, showing boiler rating and a three-dial pressure instrument indicating the windbox pressure, the draft over the fire and the stack draft. In the middle of the aisle hang two large master steam gages and one 24-in. water-pressure gage. Several recorders for pressures and temperatures are attached to the building columns. Automatic balanced-draft apparatus sets the flue dampers. Six forced-draft fans, turbine driven, deliver the air for combustion into a single large air duct 250 ft. long, from which each stoker takes its supply through two 24-in. gooseneck connections.

The operating crews are of typical steel-mill character, as the plant is surrounded by the mines, quarries and factories of the Mahoning Valley. The coal is purchased in the open market from neighboring mines and arrives by rail. As received, its calorific value ranges from 11,500 to 12,200 B.t.u. The ash content is high (13 to 16.5 per cent) and sulphur varies from 3.2 to 3.75 per cent. The moisture fluctuates between 4 and 7 per cent.

Coal-storage fires add considerably to the difficulties of operation by reducing to a great extent the volatile content and correspondingly increasing the ash content of the coal as fired. To secure good results in the face of these handicaps, it was necessary to go down to the bottom of the combustion problem.

In the typical boiler room of today the firemen have one duty that cannot be perfectly performed by any human being. This is to regulate the quantities of air and coal and maintain the proper relations between them. The fuel, or combustible matter, is a solid bulky material of varying size whose value is appreciated. The air or carburant element is an invisible gas, which is elusive and *apparently* costs nothing, being available everywhere. Notice the "apparently." These two substances combine chemically and produce definite quantities of heat. Coal burned with the theoretical amount of air generates the highest temperature, but it can also be burned with 40 per cent too little or 200 per cent too much air.

Fires on grates or stokers permit the operator to look at the fuel bed, where he can see the shape of the incandescent mass, the presence of clinkers, the formation of ash, etc., but no human being has a measuring sense for volumes of air passing rapidly through the coal. Yet combustion efficiency is largely a process of *exact* carburation. Nature, unfortunately, has not provided men with means of gaging the percentage of carbon-dioxide, which is the most vital criterion of efficient heat production. Consequently, it is illogical to ask any man to act as regulator of fuel air mixtures under varying load conditions if high efficiencies are to be maintained.

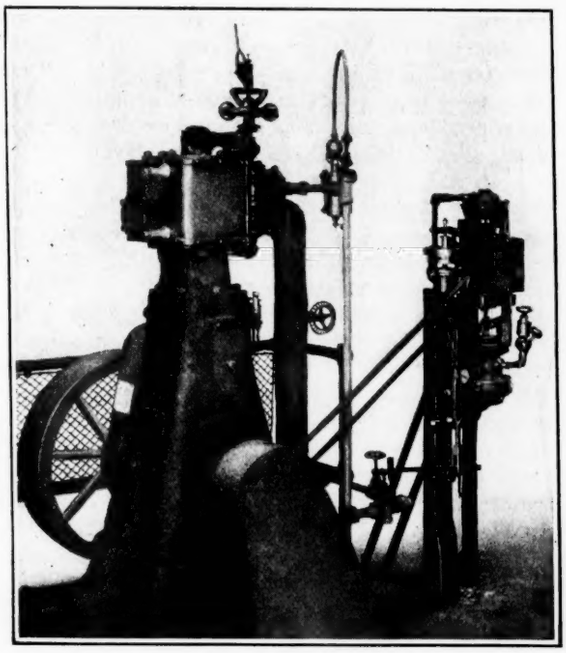


Fig. 2—Instrument regulates stoker speed according to "orders" automatically dispatched from master controller.

During the last decade the insufficiency of the human equipment for combustion work has been recognized and admitted by all experts in the art. Indicating and recording instruments of various types give a partial solution to this problem, but the human element has still to change the coal feed, vary the air flow and reset the draft dampers if the indications are such that change is desirable or necessary.

This human link in the chain causes a considerable time lag and leaves the way open for waste due to improper interpretation of instrument readings, lack of watchfulness, etc. The best of supervision cannot wholly overcome these defects.

To solve the combustion problem in its entirety, the boiler operating crew should be absolutely divorced from an impossible task, just as the operators in the turbine room are separated from the duty of speed regulation. The measuring of coal-air quantities

should, in the writer's opinion, be done automatically by machines especially designed to perform that superhuman work, and these regulating devices should be built into the plant equipment, just as governors are built into engines and turbines.

The centralized combustion-control system at Lowellville is perhaps the first large-size crystallization of this basic idea. Fundamentally, the system involves two distinct kinds of apparatus: (*a*) A central "command;" (*b*) individual regulators carrying out in a positive way the orders received, as soon as they are received.

General Layout of Control System

The command station consists of two master controllers acting as load distributors and setting the ratio between the different orders sent out. In Lowellville the master controllers installed are sensitive to the rate of steaming required by the turbo-alternators. One of these controllers can act as a spare for the other, in control of all 28 boilers. The general layout of the control system is shown in Fig. 1.

For greater flexibility the installation also permits running both controllers jointly, one controlling part of the house (18 boilers) and the other the remainder (10 boilers). These master controllers[1] have substantial cast-iron frames that can easily be bracketed to any wall or column. The bodies form an air manifold with five branch lines receiving compressed air at about 10 to 15 lb. pressure. Any clean, reliable source will do, and service air can be used in any plant by throttling down the pressure. In Lowellville, on account of insufficient compressor capacity, separate small motor-driven units were installed for reasons of safety and reliability. The top of the "masters" are made in the form of panels with indicating glass gages or mercury columns. By means of steam diaphragms and bleeding disk valves, air pressures are created which bear a definite relation to the load on the station. These pressures vary from 0.2 to 8 in. of mercury in the column. Low pressures correspond to low loads, and high pressures to high loads.

The steam header interconnecting the turbine intakes furnishes the initiative. It is well understood that the header pressures vary with the load; if the turbine governors open wide with increasing demand, this pressure drops a few points, and if the load decreases, the turbine demands less steam, which increases the main header pressure somewhat. These fluctuations, amounting to from 3 to 5 lb. in both directions, give an accurate indication and the master creates air pressures that are directly proportional and that can be set at will to suit the load conditions of the plant.

Pneumatic Dispatch System

This main air pressure is used as a basis for a comprehensive pneumatic-dispatch system of small pipes (under ½-in.). The main air pressure is shaded at will by reducing valves and bleeding orifices, and the resulting multiple "actuating pressures" are supplied to the three to five distinct lines of the system.

Each of these separate dispatch lines controls one function of the combustion apparatus. In Lowellville they are three in number—namely, the fan speed, influencing forced-draft pressure; stoker-engine speed, controlling rate of coal feed; and air dampers of each stoker, governing by their position the volume of air admitted to each fire. The positions of the breeching dampers are controlled by automatic balanced draft boxes and cylinders installed in 1920 and 1921.

There are six turbine-driven forced-draft fans in the pump-room each equipped with one regulator controlled by the fan-actuating line from the master controllers; and these six machines are piped up in parallel to do team work. In the same way the fourteen stoker engines on the boiler floor are provided with fourteen speed regulators, that receive a common impulse through the stoker-actuating line of the masters, with its fourteen branches. Each of the 28 boilers has its own volume air regulator, controlling by the forced-draft damper setting the amount of combustion air. These regulators are piped by individual branches to the air-volume actuating main of the master controllers.

By co-ordinating these actuating pressures at the master controllers, the coal feed and air quantities of each boiler are measured and made exactly proportionate to the load, and predetermine in a positive way the efficiency of combustion.

The use of specially designed centrifugal reactors on the stoker-engine regulators secures absolute parallelism of all functions over the full operating range and excludes all errors due to positions. Fig. 2 shows one regulator applied to a stoker engine.

Operation Greatly Improved

The lower portions of all the instruments are alike and interchangeable, the only differences being in the upper parts and the outside connections, which are varied to suit the particular apparatus being controlled.

In Lowellville one master controller and six fan-speed regulators went into service in July, 1923, and two masters and twenty boilers, with their engines, have been in operation since the middle of September without interruption. The complete plant went under centralized control early in January of this year and has been operating in this manner ever since.

The construction period was used to work out the incorporation of a new system within the existing organization and its understanding by the operating crews. The firemen's duties are narrowed down to the control of the physical condition of the fuel bed. Their job is to help the stoker spread the coal, to keep the fuel bed even, to dump the ashes when necessary, to admit air at the extension grates and to break up clinkers. The control operator sets the masters, the coal-air ratios, and supervises the working of the individual regulators.

Boilers Operate as a Well-Balanced Team

It appears from previous explanations that through the action of the masters, when the load increases the fans are speeded up, the stokers run faster and more air is admitted to each fire. The opposite occurs when the load decreases. As all the regulators of each type are piped up in parallel, the boilers must operate like a well-balanced team, since all get the same quantity of coal and the same amount of air. The racing of individual boilers is eliminated, as well as the loafing of others. As a result operating conditions are smooth.

The men at the masters control the nerve center of the operating system. To facilitate their very responsible task, a control house was built around the master controllers and all essential data are collected therein

[1] On account of space limitations no attempt will be made in this article to describe the details of the master regulators and individual controls. These were described in *Power*, May 23, 1922.

on an instrument board analogous to the switch panels of the turbine room.

The Lowellville instrument board is made of ¼-in. rolled-steel plate about 6 ft. by 30 in. framed into the steel skeleton of the control house. This is flanked by master controllers, one on each side (see Fig. 1). On top are six 4-in. dial steam gages reading up to 250 lb. These indicate, through ¼-in. pipe connections, the steam pressure on the six fan turbines. They tell the operator not only which fans are blowing, but also what each one is doing and how the regulators are responding. Another 4-in. dial gage indicates the oil pressure of the power system supplying the 48 regulators of the system. The 10-in. dial gage on the right side indicates the steam pressure in the main header, which also sensitizes the masters, while the similar gage on the left shows the feed-water pressure. By means of a 30-point switch (bottom center) and two indicating pyrometers (right and left) the operator can read the stack-gas temperature of any boiler in a moment, without leaving the control house, and can subsequently make sensible-heat-loss calculations or investigate baffles or cleaning schedules.

The center of the instrument board is cut out to make room for a 30-tube water-pressure gage connected to the windboxes of each stoker and the main forced-draft duct. Red-colored water fills the glass tubes and lights are put behind opal milk-glass plates, so that the operatar can see at a glance the condition of each individual fire. Without leaving his observation point he is informed which boiler is dead or off the line, or which is being dumped, what regulator is out of range, and what the resistance of the fuel bed is in comparison with the others. Abnormal windbox pressures make it possible to diagnose conditions of fires which is a great help to boss firemen. Clinker formation is often detected ahead of the critical point.

In front of the instrument board is a table, with the boiler-room log sheet and shift report book. A telautograph system makes possible written exchange of orders and information with the pumproom operator and the electrical switchboard. In addition there is a telephone.

Gas Analysis Also Centralized

All other instruments scattered around the boiler room were removed to new locations inside the control house. In particular the combined CO and CO_2 recorders were bracketed along the back wall. They permit (by a system of aspirators and 5-way valves) the taking of samples and records from any boiler to check the composition of the waste gases. Shelves are provided for tools, and an Orsat is always ready for individual checks. Two recording pressure gages, one for the air duct and the other for the feed water, complete the equipment.

Results obtained to date, while incomplete, are such that the ultimate success of the installation of remote combustion control is assured, and the anticipated objectives are within reach of achievement. The results may be summed up as follows:

First, all operating conditions are singularly smoothed down and evened up. Each boiler is compelled to do its bit and carry its share of the total load in the house. Sick fires are discovered immediately and nursed without delay.

Second, any load change is handled without trouble or fuss. An immediate response from all boilers is safely and positively assured to the operator in emergencies. This characteristic is of value not only in case of accidents, but also during the periodic sudden load drops such as those that occur at the noon hour.

Third, the boilers can be run efficiently at low ratings, and the banking hours are reduced. Boiler ratings of from 85 to 90 per cent are handled daily without resorting to the cutting out of individual units.

Fourth, the fuel efficiency has been constantly increased. While in the first six months of 1923 the average boiler efficiency of the plant was 68.5 per cent, during the latter half of year, by gradual improvement, the average performance was 71 per cent. January, the first month under full control, yielded over 72 per cent in boiler-room efficiency, which record speaks for itself in consideration of the low quality of coal used.

The master and individual control units in this regulating system were furnished by the Smoot Engineering Co. The layout of the instrument board and control house is a new development made under the supervision of B. F. Wood, V. P. in charge of engineering, R. J. S. Pigott, mechanical engineer, and J. D. Andrew, V. P. in charge of construction, all of Stevens & Wood, Inc.

Valves for Ammonia Compressors

By H. J. Macintire

In the early days of refrigeration the prime mover was usually the steam engine, which meant rather nominal rotative speeds as a rule, but as time passed the higher-speed steam engine, the internal-combustion engine and

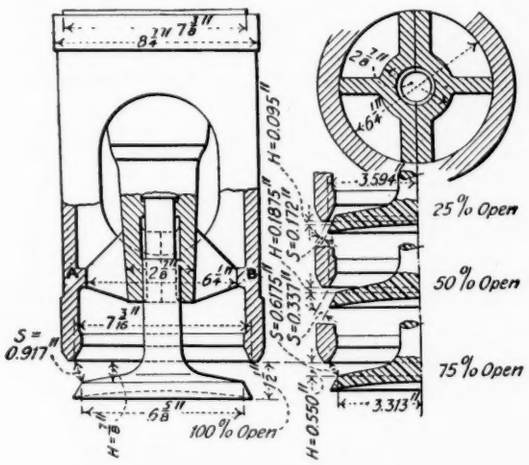


Fig. 1—Poppet-type suction valve

the electric motor resulted in a demand for high rotative speeds of the compressor. It was found, however, that one could not always speed up an old machine. Besides, the question of the stresses developed by the inertia of the reciprocating parts and the question of the balancing, there is the consideration of the valve action.

The poppet valve has been popular and successful. Fig. 1 shows a suction valve and Fig. 2 a discharge valve. These valves depend on a pressure difference to open them, both closing under spring action. But if the valves are gas operated, it means that a loss of capacity

and an increase in horsepower per ton of refrigeration result, and as the rotative speed is increased there will be a point where the slamming of the valves will be an objection. The inertia of the valve affects both the performance of the compressor and the allowable speed.

The important points in valve design are the net area of valve opening and the weight of the valve, which must be accelerated from the position of rest twice every revolution of the shaft. The heavy poppet valve

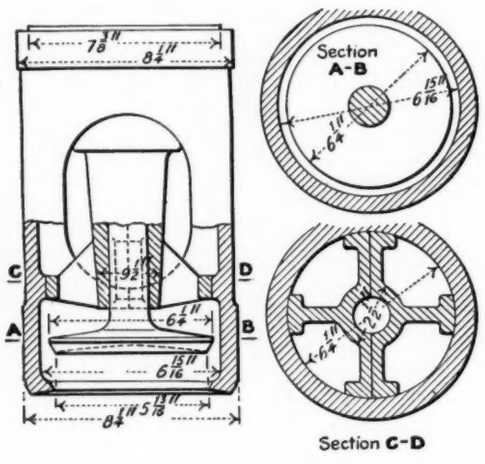


Fig. 2—Poppet-type discharge valve

has done good service in the old machines, especially under operating conditions involving high suction pressures, and they can be easily ground to their seats. The vital point, however, is to get the gas into and out of the cylinder quickly and without excessive wiredrawing. If the section of such valves is examined, it will be seen that a large area of valve opening is practically impossible and that the delay in the time of opening and of closing becomes excessive. As example, the valve is fully opened for a short time only of the stroke, as shown by the curve in Fig. 3.

How this affects the engineer can be seen from the set of curves in Fig. 4. Suppose the pressures in the

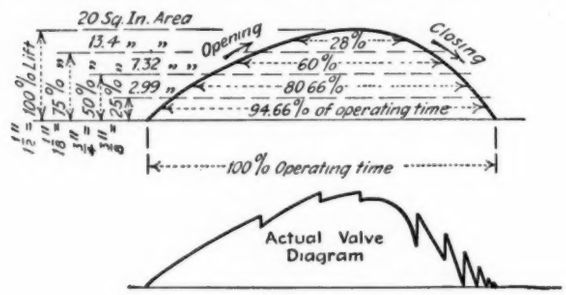


Fig. 3—Valve-opening diagram

suction and the discharge bends on the compressor cylinder are 20 lb. gage and 175 lb. respectively and faulty valves cause the pressure inside the cylinder to become 17 lb. and 180 lb. at the points of suction- and discharge-valve opening, respectively. The horsepower per ton in the first case, where the cylinder pressures equal the 20 and 175 lb. gage, is 1.38, and in the second case it is 1.52. The increase in the horsepower per ton of refrigeration is 0.14, or 10.1 per cent: The capacity of the machine drops from 4.1 cu.ft. to 4.6 cu.ft. of effective piston displacement per ton of refrigeration per minute. This decreases the capacity 12.2 per cent.

It is important for the valve to have a large area of net opening and small inertia. As seen, the type of valve and its size affect the capacity and the power requirements per unit of refrigeration. The valve opening for the flow of the gas should be liberal, requiring

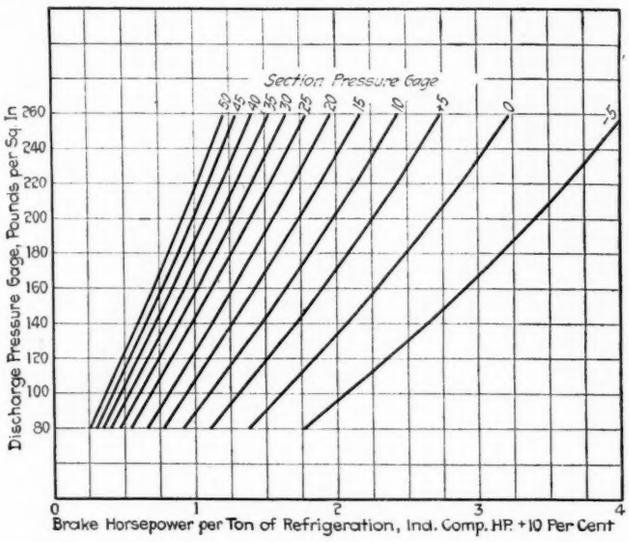

Section Pressure Gage
Discharge Pressure Gage, Pounds per Sq. In.
Brake Horsepower per Ton of Refrigeration, Ind. Comp. HP. +10 Per Cent

Fig. 4—Increase in horsepower with lower suction pressures

a low gas velocity, and the valve ports into and out of the cylinder should be short and direct. The form of valve now used for medium- and high-speed compressors is of the plate or the ribbon type, usually designed so that a number can be placed in the cylinder, thereby providing sufficient area of opening. Incidentally, clearance does not increase the horsepower per ton to any extent.

Fatigue of Heater Tubes

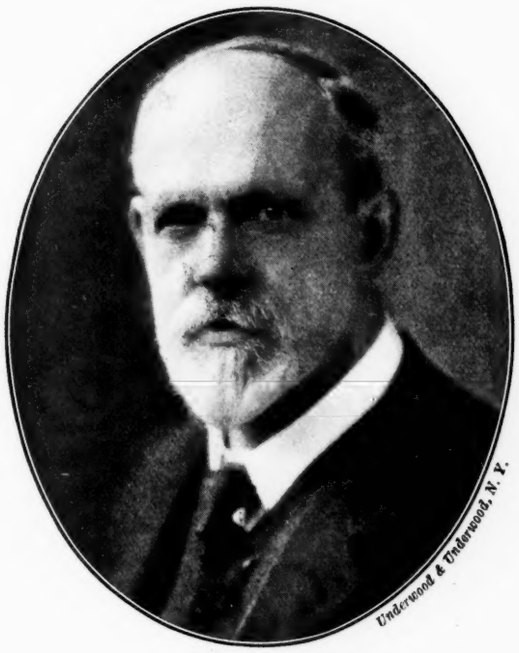
A recent paper presented at the annual meeting of the Institute of Metals, London, describes a curious failure of brass tubes of a feed-water heater. By a process of elimination the cause of failure was diagnosed as "fatigue" due to vibration. New tubes, suitably stayed, were fitted and the trouble ceased, but it still remained to consider the exact nature of the process by which the failure occurred. In the course of the account of this investigation, involving a study of the close-packed cubic material, the authors show how a movement on octahedral planes, which they term "easy glide" in distinction to "clip," is responsible for:

1. Plastic deformation in hot and cold working.
2. Changes of packing from cubic to hexagonal.
3. Mechanical twinning.
4. Fatigue.

Stress-strain diagrams are discussed taking the "easy glide" into account. This is developed to show the movement that will take place in an aggregate of crystals under cycles of stress and that, in certain circumstances, twin bars (Neumann lamellæ) are cumulatively formed in the material, which not only stiffen the crystals, but also cause them to become internally stressed, until eventually failure results. This new "fatigue" theory of the authors is compared with the observed facts of the actual failure.

William H. Patchell Outlines Power Developments

On March 21 the Institution of Mechanical Engineers (Great Britain) listened to a notable address by its president, William H. Patchell. With the background of an experience starting in 1862 and growing with the power industry up to the present moment, Mr. Patchell's address was full of human interest and keen observations on the extraordinary changes that are now taking place. The following digest of his remarks contains much of interest to American engineers.



William H. Patchell

WITHOUT the turbine steam-power development could never have progressed as it has. The limit was from 5,000 to 7,000 kw. as long as we depended on the reciprocating engine. By the aid of the steam turbine 50,000-kw generating units are equally practicable.

Efficiency Comparison of Stations

So far as I have ever heard, the first figures published showing the thermal efficiency of electric power stations on units delivered were those in the *I. E. E. Journal*, 1906, vol. XXXVI, pp. 154-7. The best then were as shown in Table I.

TABLE I—PERFORMANCE OF BEST STATIONS IN 1906

	B.t.u. per Kw.-hr.	Efficiency, Per Cent
Berlin	29,440	11.58
Carville (6 months)	39,130	8.72
Boston, Mass.	45,450	7.51
Glasgow	47,250	7.22
Manchester	48,200	7.08
Charing Cross (Bow)	50,960	6.70

British figures obtained in 1918 showed that forty stations, which generated practically half of the total amount of the electricity used in Great Britain, operated at an average of 11.5 per cent efficiency and the rest at 6.8 per cent. The best record was 12.35 per cent for a yearly output of 46,000,000 kw.-hr.

The Electricity Commissioners' 1923 report showed a great improvement, as indicated by the results of the five stations in Table II.

TABLE II—PERFORMANCE OF HIGH-GRADE PLANTS IN 1923

	Thermal Efficiency, Per cent
Newcastle Co., Carville *B*	17.80
Newcastle Co., North Tees	17.15
Rotherham Co., North Tees	16.70
Newcastle Co., Dunston	16.50
Hackney, London, *E*	15.40

Table III gives some of the figures recently obtained for British and American stations. The figures are very interesting and instructive, but must not be too closely compared as between stations with different load factors.

The twoscore years from 1881 to 1923 showed progress in size of units and pressure, but what of the next twenty years? I have had to consider with my friends in the United States the arrangement and details of plants incorporating boilers of 30,400 sq.ft. heating surface, 400 lb. working pressure, turbines of 50,000-kw. capacity, with a single barrel, also steam-boilers with pressures of 1,200 lb. per sq.in. with suitable turbines. To give an idea of what these units mean, one of the big boilers such as are now being erected at the Trenton Channel plant of the Detroit Edison Co., will generate steam to develop about 25,000 kw. I thought I was doing well twenty years ago in running 4,000 kw. off one boiler. Now such a boiler seems not much more than a kettle.

Why are such units not only possible but practicable in the United States? It is not because American engineering is better, either in design, workmanship or material than our own; it is the direct outcome, not of their engineering but of the skill and zeal of those who handle the sales department of the electricity-supply undertakings. The American consumption of electricity per head of population per year would never have been 500 to 700 kw.-hr. if it had been left to the consumer to go out and buy it.

I will now indicate the direction in which progress points at present, and mention some of the limitations. The generation of steam at 3,200 lb. pressure, as conducted on a small scale at Rugby, is highly interesting, but the pressure would appear to militate against its consideration for large power plants in the present state of the art. It is reported that this boiler has just been successfully tested[1] at full pressure and 725 deg. F.

To sum up the matter, with the best of apparatus, design and material now available, we cannot on paper see more than one kilowatt-hour produced from a pound of best Welsh coal. The performance of the two or possibly three plants[2] for which 1,200-lb.-pressure boilers and turbines are now on order will be watched with much interest. In high-pressure installations trouble and expense in maintenance will occur in pipes and fittings. In an experimental plant the turbine can be located near the boiler; in a commercial plant it is not practicable, so unusual expansion strains have to be provided against. Small leakages at such high pres-

[1] See *Power*, March 18, p. 457.
[2] Reference is here evidently made to the American installations at Weymouth and Calumet.

sures cannot be allowed to wait. They demand instant attention as the cutting action of the steam will quickly put the fittings beyond repair. The difficulty of cracking flanges or other joints at such pressures will doubtless lead to the general use of welded joints.

Structural considerations will, I fear, limit the size of high-pressure units until more experience has been obtained, and they will no doubt lead to the development of designs of boilers very unlike those now obtaining, while the high-pressure steam will tend to decrease the size of the turbine castings and so mitigate some of the dangers.

The mercury vapor turbine developed by Mr. Emmet at Schenectady, and operating at Hartford, Conn., is still another alternative which, however, has more claims for the betterment of existing plants than as forming a unit in a new large station, but it should be mentioned as it may take a larger field than at present seems probable. The inadequacy of the supply of mercury may cause some anxiety. Although this is the first binary-fluid system to be brought to such a stage of development, its success may have a stimulating influence on other combinations which will ease a mercury famine.

TABLE III—PRESENT PERFORMANCE OF TYPICAL STATIONS

(Part of original table omitted)

Station	Yearly Output Millions of Kw.-Hr.	Load Factor (on 30 Minute Max. Load)	B.t.u. Per Kw.-Hr.	Thermal Efficiency Per Cent
Glasgow Corporation, Dalmarnock	183.20	27.6	20,150	16.94
Newcastle E. S. Co., Carville *B*	234.27	48.5	20,720	16.47
Newcastle E. S. Co., North Tees	97.95	34.4	21,130	16.15
Lancs. E. P. Co., Radcliffe	101.20	31.0	21,950	15.54
Newcastle E. S. Co., Dunston	128.90	24.9	22,850	14.94
Bradford Corp., Valley Road	76.39	27.5	25,010	13.65
Manchester Corp., Stuart Street	200.94	29.9†	25,140	13.57
Milwaukee, Wis., Lakeside	313.84	45.3	18,030	18.93
Detroit, Mich., Marysville	147.95	47.3	18,923	18.03
Chicago, Ill., Calumet	517.71	40.8	19,215	17.76
Cincinnati, Ohio, West End	410.48	43.8	19,490	17.51
Philadelphia, Pa., Delaware	468.35	42.8	19,600	17.41
Duquesne Light Co., Pa., Colfax	694.08	61.8	19,610	17.40
Detroit, Mich., Connors Creek	695.87	49.9	19,666	17.35
Philadelphia, Pa., Chester	278.66	52.2	19,930	17.12
Newark, N. J., Essex	498.73	45.5	20,930	16.30
Boston, Mass., L Street	482.33	39.0*	21,520	15.86
Chicago, Ill., Northwest	813.10	55.5	21,960	15.54
Hartford, Conn., South Meadow	99.44	33.4	23,720*	14.39*
Chicago, Ill., Fisk Street	899.34	46.6	24,030	14.20
Detroit, Mich., Delray	502.55	53.8	24,464	13.95

* Indicates approximate figures only. †Indicates 60-minute maximum load.

Makers are willing to offer turbines and boilers for 1,200 lb. pressure and, say, 750 deg. steam temperature, but much more knowledge of what may happen is wanted to insure a feeling of security to those who have to operate such a plant. Higher pressures call for thicker materials, but there are limits to the thickness of plates that can be worked. Alloy steels call for more skillful handling. The pressures and temperatures proposed open out lines upon which we have not yet traveled. Are these lines ready yet for use? May we hope that our grandchild "Ferrous Alloys Research" will produce a super-steel worthy of the occasion and of its parentage? About 1904 the Stirling Boiler Co. made a four-drum boiler of 1,850 sq.ft. heating surface for 500 lb. pressure, which I am informed is still at work—a unique case, I believe. Could we contemplate the use of nickel, vanadium or other alloy steels in ordinary boiler shops? I think not.

Professor Lea finds that a mild steel containing, say, 0.14 per cent carbon, will at 752 deg. F., break in one hour at a stress of from 50,000 to 60,000 lb. per sq.in. If, however, this steel is tested at a temperature of 752 deg. so as to determine the stress at which there is no continuous change of form, or in other words the stress a slight increment of which will produce fracture in a very long time, then the critical stress is only about 28,000 lb. per square inch. That is, if working stress in a tube is 10,000 lb. per sq.in., the factor of safety is less than 3. Furthermore, if the temperature is raised to 932 deg., the critical stress is only about 8,000 lb. per square inch. It would appear, therefore, that in boiler work, as long as the temperatures are not more than 750 deg., there is an ample factor of safety, but if it is possible for the temperature to approximate 930 deg., unless the working stress is very small, the factor of safety will be small.

It is interesting in connection with these matters, which are now so prominently before us, to note what circles we are running in, and how many inventions are born before their time. Ernst Alban used steam at 1,000 lb. in an engine before 1850. In 1852 reheating was patented by Daniel Adamson and Leonard Cooper, in connection with compound engines. It is only now that we are beginning to appreciate the full value and importance of these things.

Possibilities of Pulverized Fuel

In larger establishments we have power and steam-raising stations that handle all the different classes of coal, but the varieties that any one station will handle economically are limited, and so we often find ourselves restricted to coal of one particular class. It is just here where pulverized fuel, of which we have heard a great deal in the last few years, helps us. When burning coal pulverized, it is much easier to make such changes as are necessary to handle coals of different volatile content or of varying ash content and fusing point, hence this system is being adopted in preference to burning lump coal where a continuity of supply of a given coal cannot be relied upon.

The efficiency of the best mechanical stokers, when properly set and handled, is very high; indeed, there is little difference between their performance and powdered coal burning. It must be borne in mind, however, that although stoker efficiency may be slightly improved, there does not appear to be much room for real improvement. On the other hand, the use of powdered fuel under boilers is new, and while the thermal efficiency may be high, the cost of preparing the fuel and of constructing the furnace should be and is being greatly improved upon.

To what extent powdered coal is going to help us is very much "in the lap of the gods." The keenest boiler-house engineers have taken it up, as they know where they found the stoker and to what pitch of perfection they have brought it, and they, knowing how little difference there is between stoker and pulverized fuel firing at present, are of the opinion that they can improve on the latter as the result of practical operation and experience with it.

The use of large boiler units and large combustion chambers enables a compact and convenient arrangement of boiler room to be adopted and a high boiler efficiency to be obtained over a large range of duty. With coal-firing we cannot reach the comfort of oil-firing conditions, but we can approach it.

Henry Ford is building a full-scale low-temperature-carbonization plant at his new works in Detroit, to treat 4,000 tons of his own coal a day on a bath of molten lead. It is admitted that there are a number of com-

mercially unsolved problems to be developed, but the facilities for using the coke, gas, motor spirit and tar all in his works, with Mr. Ford's boundless energy and persistence, with his financial ability to see through to a conclusion any scheme he takes in hand, makes one hopeful that real good may eventually come from the venture.

The oil and gas Holzwarth turbines are reported after successful tests as ready to come on the market. A 700-kw. gas and a 300-kw. oil turbine have already been run, following other experimental machines, and a 5,000-kw. gas turbine is practically completed ready for running. The trials have shown high thermal efficiencies, and that the average temperatures to which the turbine blades are subjected do not exceed those obtaining in a modern steam turbine. This is, indeed, welcome news if prolonged use will substantiate the shop runs that have been made. At any rate the knowledge and experience in turbine construction that is available today is so far ahead of what was obtainable for many years after the first steam turbines were running that we may expect the development of gas turbines to be rapid. Personally, I feel convinced that in a short time we shall be seeing these things as well as the commercial utilization of our lignite and other low-grade fuel stocks as accomplished facts.

Allen Salt-Velocity Method of Measuring the Flow of Water*

A great deal of interest has been evidenced in the Allen salt-velocity method of measuring water, and this article has been prepared to give a simple explanation of the principles involved, to show some of the results of the experimental work done in the development of this method and how a quantity of salt solution may be expected to act when carried along by a current of water.

ALTHOUGH the most accurate way of measuring water is by weighing, this method is limited to comparatively small quantities. Where large quantities are involved, such as in hydro-electric plants, it is general practice to measure the rate of flow through a penstock or canal of known cross-section and from these calculate the volume. There are various ways of doing this, but none of them is applicable to all conditions. For many power plants, particularly low-head plants with short concrete penstocks, many of these methods are too expensive or too inaccurate. The Gibson method, which has a high degree of accuracy, is limited to closed penstocks of considerable length.

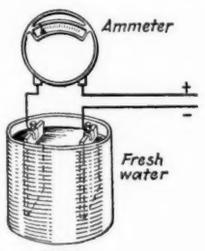


FIG.1

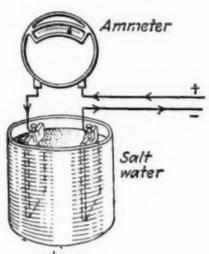


FIG.2

Figs. 1 and 2—Fresh water a non-conductor and salt water a conductor of electricity

For some time there has been a growing need for some simple and accurate way of measuring water to hydro-electric stations with short penstocks as well as to those with longer ones, and the Allen salt-velocity method has been developed to met such conditions.

This method is based on the fact that salt in solution increases the electrical conductivity of water. For example, if two metal plates (electrodes) are immersed in a jar of fresh water and connected in a circuit through an ammeter, as in Fig. 1, it will be found that the meter indicates no current flowing. If the fresh water is replaced by a salt solution, as indicated in Fig. 2, a current will flow which will be indicated by the ammeter. Another fact involved in this method is that if a quantity of salt solution is introduced into fresh water flowing through a pipe, although the solution may tend to spread out and mix with the water, its point of greatest density will retain practically a fixed relation to the rate of flow in the pipe line. This is illustrated in Figs. 3 and 4. If a charge of salt solution is introduced in the pipe line at *A*, it has been found by experiment that the center of density of the solution will be carried along at a rate practically equal to the mean velocity of the water in the pipe. That is, if it is 30 ft. from *A* to *B*, Figs. 3 and 4, and the water has a velocity of 3 ft. per sec., the center of density of the solution will move from one position to the other in $30 \div 3 = 10$ sec. By combining the principles explained in Figs. 1 and 2 with those in Figs. 3 and 4, the rate at which water flows in a pipe line can be determined accurately and is the fundamental principle of the Allen salt-velocity method of water measurement.

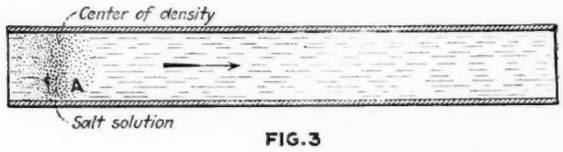


FIG.3

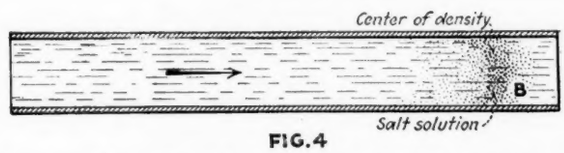


FIG.4

Figs. 3 and 4—Show how a charge of salt solution will act when carried down a pipe line with the water

Figs. 5 to 7 show schematically how these measurements are made. Two sets of electrodes are placed in the pipe line a measured distance apart, and to each set is connected a source of electric current with an

*This article is based on a paper, "The Salt-Velocity Method of Water Measurement," by C. M. Allen and E. A. Taylor, presented at the annual meeting of the American Society of Mechanical Engineers, Dec. 3 to 6, 1923.

ammeter in circuit. In Fig. 5, since these electrodes are in fresh water, no current will flow and the meters will indicate zero. To measure the flow, a charge of salt solution is introduced into the pipe line or penstock on the upstream side of electrodes *A*. As this charge is carried down with the current, it is brought in contact with electrodes *A*. At first the less-dense portion of the solution and current begins to flow, which causes the ammeter needle to begin to move over the scale. The needle continues to move across the scale until the densest portion of the solution comes in contact with the electrodes, when a maximum reading will be obtained. As the flow continues past the electrodes, they again come into less dense solution, which causes the resistance of the electric circuit to increase and the current to decrease, causing the needle to return back over the scale until it reaches zero when the solution has passed. The solution is carried along with the current until electrodes *B* are reached, and as it passes the electrodes, ammeter *D* gives a somewhat similar series of readings as did *C*. Now if the time is taken between the two maximum readings, it will be found to represent very closely the correct period of flow between the two sets of electrodes. The true mean velocity is indicated by timing the center of gravity of the charge of salt solution, and in pipes of considerable length the point of maximum conductivity and center of gravity practically coincide. However, what has been shown in Figs. 5 to 7 is essentially the Allen salt-velocity method of measuring the flow of water. The salt solution being carried down by the water is similar to a large number of floats, and the ammeter indicates the number of the floats that are in

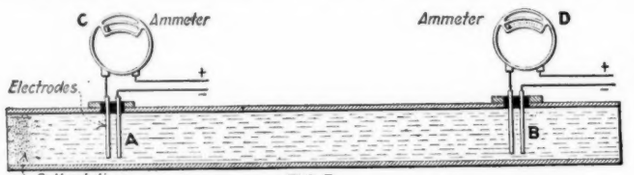


FIG.5

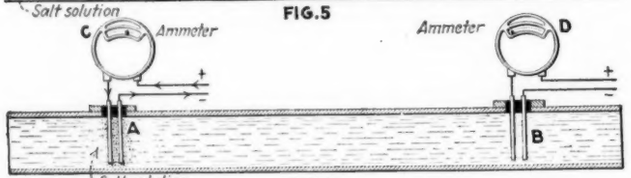


FIG.6

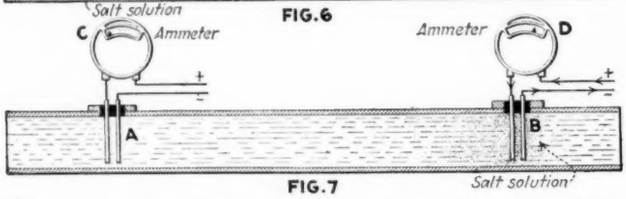


FIG.7

Figs. 5 to 7—Show one way of applying the Allen salt-velocity method of measuring the flow of water

contact with the electrodes at any time, giving a maximum reading for the maximum number.

Early in 1921 the development of this method was begun with laboratory tests at the Worcester Polytechnic Institute. In September, 1921, the first commercial tests were made on two units of a power plant. In 1922 Prof. C. M. Allen and Edwin A. Taylor conducted extensive investigations at the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute and at the power plant of the Laurentide Power Co., at Grand Mere, Quebec. In the fall of that year ten successful commercial tests were made. Both the laboratory investigations and the commercial tests were continued through 1923.

Plant No. 1 of the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute, Worcester, Mass., was used for the first of these tests. Fig. 8 shows the layout of this plant. The water supply is from two

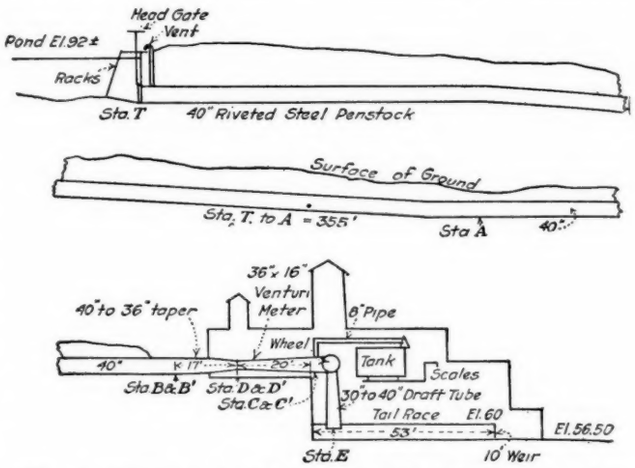


Fig. 8—Layout of Alden hydraulic laboratory, where experimental work has been conducted

ponds with a combined area of 200 acres, and a constant head can be maintained for long periods. A total fall of 35 ft. is available.

The penstock is a riveted steel pipe about 450 ft. long. From the pond to within ten feet of the laboratory the diameter of the pipe is 40 in. In the laboratory are a 36-in. by 16-in. venturi meter, an 18-in. horizontal waterwheel with cylindrical case and a conical vertical draft tube discharging into a tailrace at the lower end of which is a 10-ft. standard sharp-crested weir with end contractions.

In the first tests raw salt was introduced into the penstock and only one set of electrodes were used, which were located at the lower end of the penstock. The operator punched the stop-watch when the salt was introduced and then ran down the road to the laboratory, where an ammeter was connected to the electrodes, and again punched the watch on the first deflection of the meter needle.

The first improvement in the introduction of salt was a closed metal box containing a charge of salt, which was lowered to the mouth of the penstock by a pole. The charge of salt was released when the hinged sides of the box were raised by wires operated from a platform over the head gate. Raw salt or solution was also placed in paper bags tied to a pole, and when lowered to proper position the bags were broken by a sudden motion of the pole.

Later, salt was injected in a solution piped from an elevated mixing tank over the head gate. A 2-in. pipe led to a quick-acting valve, operated by a rod from the surface platform. The valve was fitted with a vertical deflecting plate and the scavenging tubes and was placed facing downstream in the plane of the penstock entrance. The strength of the charge could be varied by changing the degree of saturation of the solution or by throttling at a slow-motion valve in the feed pipe. Fig. 9 shows the head gate, pipe and valve.

The first pair of electrodes used were thin strips of copper, 38 in. long and 2 in. wide, spaced 2 in. apart by wooden blocks. These electrodes were placed in a horizontal position across the center of the pipe and held in place by wooden wedges, Fig. 10. Similarly constructed electrodes 6 in. long were used for traversing the pipe. These electrodes were fastened to a rod

TABLE I—RESULTS COMPUTED FROM TIME OF INITIAL APPEARANCE OF SALT AND FROM MEAN OF TOTAL APPEARANCE

Q by Weir, Second-Feet	*Q* Computed, 1.095 × Initial Time	Variations Per Cent	*Q* Computed, 0.865 × Mean Time	Variations Per Cent	*Q* Computed, 0.900 × Mean Time	Variations Per Cent
6.4	6.4	0.0	7.3	+14.1	7.0	+9.4
13.6	13.4	—1.5	13.7	+0.7	13.2	—2.9
18.1	18.3	+1.1	18.1	0.0	17.4	—3.9
21.4	21.4	0.0	21.4	0.0	20.6	—3.7
26.3	26.5	+0.8	26.3	0.0	25.3	—3.8
32.0	32.0	0.0	30.6	—4.4	29.6	—7.5
35.6	35.7	+0.3	32.6	—8.4	31.4	—11.8
21.8	21.8	0.0	23.4	+7.3	22.5	+3.2
24.9	24.9	0.0	26.6	+6.8	25.6	+2.8
29.9	29.9	0.0	31.8	+6.4	30.6	+2.3
31.6	31.3	—1.0	Traverse			
32.0	32.0	0.0	33.3	+4.1	32.0	0.0

passing out of the pipe through a stuffing box and could be held at any position along the diameter of the pipe, Fig. 11. Usually, during a traverse these small electrodes would be held in ten different positions.

All electrodes were connected by wires and switches to the indicating meters. In 1921 only indicating voltmeters and ammeters were used to show the current between the electrodes. Direct current at 110 volts was used on the circuits.

Soon after the first few tests had been made, a telephone line between the pond and laboratory replaced the running operator. The stop-watches were then started by the operator at the laboratory on verbal

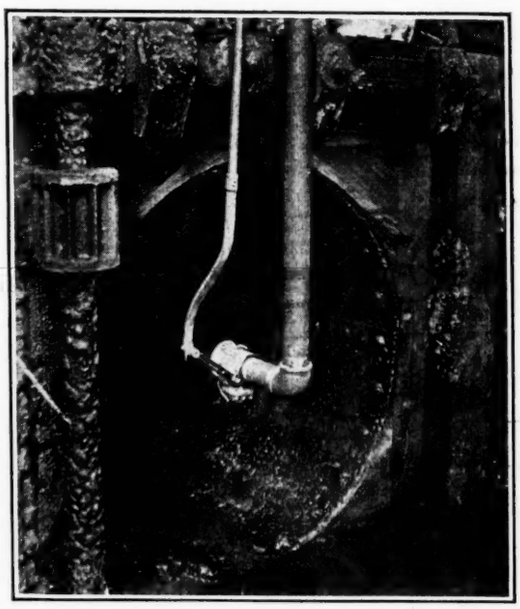


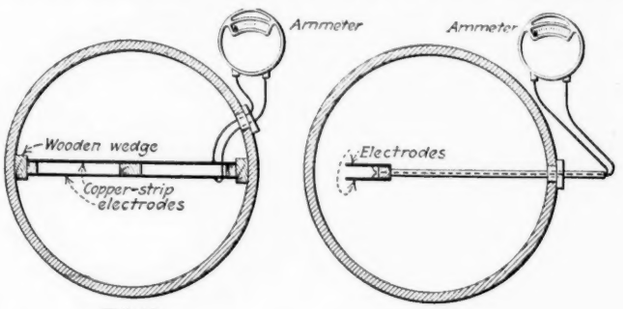
Fig. 9—Head gate, mouth of penstock and 2-in. quick-acting valve

signal from the pond operator, and the time was observed at various stages of the needle deflection. As a rule, two watches were used. The first one was stopped on the initial appearance of the salt, the second at final appearance, and the intermediate stages were observed by metronome with the second watch running.

Including trials, about 400 charges of salt solution (one charge called a "shot") were used in these tests, which were grouped into 30 runs of from 10 to 20 shots at each gate opening. Runs at each gate were repeated six to eight times.

During the 1921 series of laboratory tests, the computation of the discharge by the salt-velocity method for comparison with the quantity indicated by the weir was made by three different methods:

1. The time was computed from the moment of salt introduction to the initial appearance of the salt at the electrodes, which was indicated by the first movement



Figs. 10 and 11—Arrangement of electrodes in pipe line

of the ammeter needle, and a coefficient 1.095 was computed to give the true quantity *Q*. This coefficient remained constant for all gate openings and velocities.

2. The time was computed from the moment of salt introduction to the point of mean time between the initial and final appearance of the salt at the electrodes; that is, halfway between the beginning and end of the curve, and coefficients were computed to give the true quantity *Q*. These coefficients varied and no constant could be established.

3. The time was computed from the moment of salt introduction to the moment of maximum density of the

TABLE II—RESULTS COMPUTED FROM TIME OF MAXIMUM DENSITY OF SALT

	Salt Solution Through Pipe and Valve		Solid Salt or Solution in Paper Bags	
Gate Opening, Per Cent	*Q* by Weir	*Q* Computed From Max. Appearance of Salt	*Q* by Weir	*Q* Computed From Max. Appearance of Salt
20	14.4	14.24	13.4	13.507
30	17.6	17.512		
30	16.9	16.731		
40	18.3	18.263	18.8	18.837
40	18.2	18.000		
40	19.6	19.580		
50	22.3	22.255		
50	21.8	21.582		
60	23.9	23.780	22.8	22.663
70	25.6	25.600		
— 80	27.3	27.272		
80	27.6	27.545		
80	27.4	27.455		
100	28.9	29.045	29.2	29.200
100	30.0	30.030		

salt solution passing the electrodes—that is, the point of maximum deflection of the needle or the peak of the curve—and a coefficient was computed to yield the true quantity by weir. This coefficient was approximately 1.00 (averaged 0.9975). The length and diameters of the section of pipe used were carefully measured and the volume of the section computed. Then

$$\frac{Vol.\ (cu.ft.)}{Time\ (sec.)} = cu.ft.\ per\ sec.$$

The quantity by weir was computed by the Francis formula $Q = 3.33(b - 0.2H)H^{\frac{3}{2}}$. The heads over the weir crest varied from six inches to one foot.

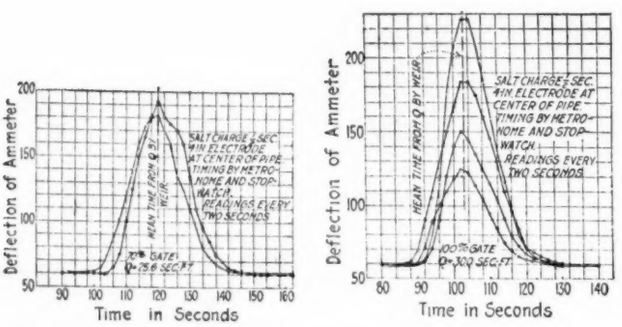
The results of computations by each of the foregoing methods are given in Tables I and II. The tests in Table I were all made by injecting solid salt through the metal box. This table was taken from a thesis by

Messrs. Bijur and Scanlan of the class of 1921, Worcester Polytechnic Institute.

Figs. 12 and 13 show curves obtained by plotting ammeter deflections against time in seconds. The maximums of these curves fall practically on the same vertical line. Furthermore, the location of the maximum of the curves is not affected by the specific gravity of the salt solution. In Fig. 13 the curves are given for four charges of salt at different specific gravities, and in every case the maximum of the curve falls very closely on the same vertical line. It will also be observed that the initial and final appearance of the salt is not materially affected by the specific gravity of the solution. The initial side of the curve, which is on the left, is somewhat steeper than the final. Another thing to be observed in Fig. 13 is that the time between the initial and final appearance of the salt is approximately 50 sec. Since the rate of flow in the pipe line is about 3 ft. per sec., the length of the salt charge when it passed the electrodes was about $50 \times 3 = 150$ ft. In this case salt solution was used and introduced as indicated in Fig. 9 and allowed to flow into the pipe line for one-half second. Then, with a 3 ft. per sec. flow in the pipe line the length of the charge was only $1\frac{1}{2}$ ft. However, by the time it reached the electrodes 355 ft. down the pipe, it was 150 ft. long, but the point of maximum density of the solution remained in a fixed relation to the rate of flow.

Fig. 14 shows curves illustrating the percentage of the true quantity (by weir) obtained by computing the salt-velocity results, using the mean between the initial and final appearance, the time of maximum density, and the time of initial appearance of the salt. During the tests the interior of the pipe was cleaned, and the results are shown both before and after cleaning.

In obtaining the values for these curves two 4-in. electrodes were used mounted on the end of a rod which passed through a stuffing box on the side of the pipe. The electrodes were placed at a measured distance from the side of the pipe and tests made with the electrodes at seven different points across the diameter of the


Deflection of Ammeter
200
150
100
50
90 100 110 120 130 140 150 160
Time in Seconds
SALT CHARGE 2 SEC. 4 IN. ELECTRODE AT CENTER OF PIPE TIMING BY METRONOME AND STOP-WATCH. READINGS EVERY TWO SECONDS
MEAN TIME FROM Q BY WEIR
70% GATE
Q=75.6 SEC.FT
Deflection of Ammeter
200
150
100
50
60 90 100 110 120 130 140
Time in Seconds
SALT CHARGE 2 SEC. 4 IN. ELECTRODE AT CENTER OF PIPE TIMING BY METRONOME AND STOP-WATCH. READINGS EVERY TWO SECONDS
MEAN TIME FROM Q BY WEIR
100% GATE
Q=100 SEC.FT

Figs. 12 and 13—Sample curves from tests made on 40-in. pipe 355 ft. long

pipe. During these tests the pipe line was cleaned, and it will be observed that when the mean time and initial time for the salt velocity were used, two different sets of value were obtained, one before and another after cleaning the pipe. When the time of maximum density of the salt solution was used, practically only one set of values was obtained, and these gave approximately the correct time for the flow of the water in the pipe. These curves show not only the shape that the salt-solution charge may take in the pipe, but also that the time of maximum density can be relied upon to give the correct time. If the mean or the initial times are used to obtain the flow, not only may the results be in error, but they may be materially affected by the condition of the pipe line.

Since the experiments have been conducted, the method has been checked in practice by tests on a number of installations and a high degree of accuracy obtained, not only in penstocks of uniform cross-section

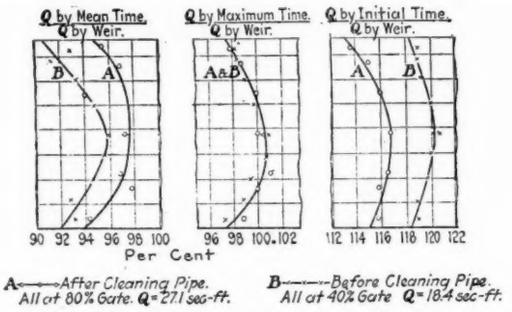

Q by Mean Time. Q by Weir.
Q by Maximum Time. Q by Weir.
Q by Initial Time. Q by Weir.
B
A
A&B
A
B
90 92 94 96 98 100
96 98 100 102
112 114 116 118 120 122
Per Cent
A——After Cleaning Pipe. All at 80% Gate. Q=27.1 sec-ft.
B——Before Cleaning Pipe. All at 40% Gate Q=18.4 sec-ft.

Fig. 14—Curves of traverse tests on 40-in. pipe with various methods of computation

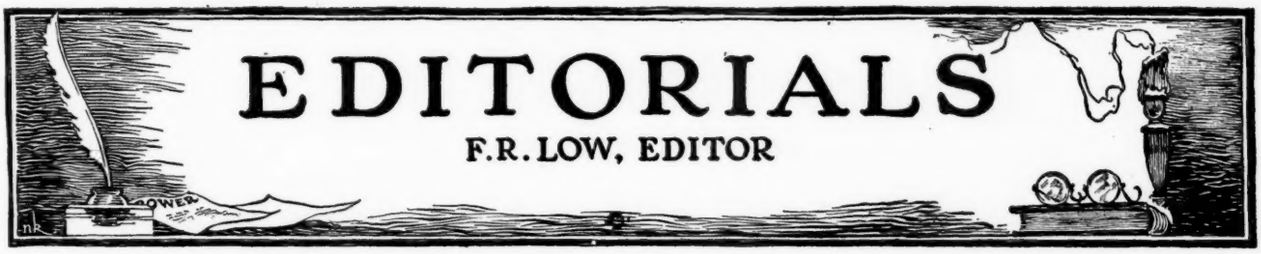
but in those with varying cross-sections. Means have been perfected for introducing the salt solution into the penstock and improved type of electrodes developed so as practically to eliminate any slight errors that might have existed in the early laboratory tests and curve-drawing ammeters and other electrical instruments used to give an accurate record of the salt passing the electrodes. Future articles will give the results obtained and methods used in making recent laboratory and commercial tests.

Inspecting Hydro-Pneumatic Elevators

Hydro-pneumatic or hydro-air elevators are reasonably satisfactory when operating between terminal landings. Inspectors should satisfy themselves that the packing in the gland of the plunger is both loose and resilient, for if the packing is hard or is pressed down too tightly by the gland, the car will not start downward promptly when the control valve is opened on the down travel. The water in the plunger casing and in the system will travel back into the tank when the air-discharge valve is open; then, when the car does start downward, it must drop some inches, until its weight brings the pressure in the system up to the point where it will sustain the load. It should also be determined that the opening of the air-discharge valve on top of the tank is a fraction of a second later than the opening of the water valve on the bottom of the tank; for, obviously, if the air valve opens first or even simultaneously with the water valve, the car will start downward too suddenly.

Inspectors must, under no circumstances, enter the pit below the platform of this type of elevator unless they have the platform solidly braced, so that, even should the control be placed on the down position, the car cannot travel downward.

During the last two or three weeks several of the large utilities companies have announced reductions in their rates for electricity, especially the maximum rates as applied to domestic consumption. This is a substantial testimonial to increased efficiency in operating methods in spite of increased labor and material costs.



Principles or Applications?

IN THE time-worn adage, "There is nothing new under the sun," is probably contained more truth than fiction, but this does not depreciate the importance of the application of any principle to a new condition no matter how long the basic idea may have been known or who may have made the original discovery.

The fact that the principle of the reaction-type steam turbine was discovered over two thousand years ago and the impulse principle was known of and applied some three hundred years ago, does not subtract in the least from the inventive genius of DeLaval and Parsons who, working separately during the years 1882 to 1889, laid the foundation for not only the modern steam turbine, but present-day steam power-plant engineering. Nor does the work of these men discredit the contributions of the great army of scientists, inventors and engineers who have helped to make the modern steam turbine what it is today.

Although the advantages of high-pressure steam have been known for over one hundred years and such pressures used, it is only now that commercial applications are really being made. Dr. Ernest Albans not only appreciated the economies to be gained in the application of high-pressure steam, but also had a clear and comprehensive understanding of the problems involved in the use of pressures up to one thousand pounds. Anyone who has read his book, "High-Pressure Steam Engine," published in 1843, cannot help being impressed with the fact that he practically stated the problems just as we find them in our present-day applications. With all due credit to Dr. Albans, Jacob and Loftus Perkins and other early experimenters with high-pressure steam, it has remained for the inventive genius of the engineers of the present century, given an opportunity through modern power generating practices and and manufacturing processes, to make the high-pressure steam boiler a commercial article.

The original idea of a draft tube for a hydraulic turbine dates back to 1840, when the first patent was taken out in this country. This was a long rectangular box, the purpose of which was to allow the wheel to be placed above tailwater. Apparently, a gain in turbine efficiency was not a function of this draft tube. About six years later the application of a draft tube to regain the velocity head in the turbine discharge, was tried by Boyden with fair success. The tubes were designed in the form of a diffused or bell, shaped somewhat like the bell of some draft tubes in use today. This idea was later improved upon by Swain, who placed a center cone in the diffuser. The cone extended up to the center of the runner, as is the case in one type of modern draft tube. However, these facts do not depreciate one iota the work that is being done at the present time. Waterwheels in one form or another date back so far that their origin is lost in antiquity. But the present high-efficiency hydraulic turbine is a product of the last twenty years. This does not in any way detract from the work of the earlier pioneers who contributed so much to the development of the hydraulic turbine and whose wheels met the needs of their time quite as successfully as the modern turbine and draft tube meet the requirements of the present enormous power developments.

Instances like these could be cited through practically the whole range of engineering, but they do not show that the work of the modern engineer is any less important than that of his predecessor of fifty or one hundred years ago, which not infrequently is held up as something to discredit the work of those who are meeting the problems of today as they find them.

The Future of Power

NOW and then it is good for an engineer to cease squinting at the details of his own little problems in order to make a bird's-eye survey of his industry or profession—whichever he chooses to call it. Any general survey of the field must answer three questions: Where are we now? How did we arrive at this point? Whither are we bound?

Only a man fully prepared to answer the first two questions is competent to attempt the third. No one could be better fitted for this task, by virtue of his good judgment and his long and noteworthy experience in the power field, than William H. Patchell, president of the Institution of Mechanical Engineers of Great Britain. Two pages of this issue are devoted to his recent presidential address on power development. Space limitations have made necessary the omission of his reminiscences of the earlier days of steam engineering, but the gist of Mr. Patchell's observations on present conditions and the trend of development has been retained.

No engineer should be too busy to read this over and check the observations and comments against his own conceptions. There is doubtless a big grain of truth in Mr. Patchell's statement that merchandizing skill in the sale of energy lies at the root of the enormous power development in the United States. On high pressures and the mercury turbine his attitude is cautious but not reactionary. Powdered fuel, in Mr. Patchell's opinion, has a most promising future in Great Britain as well as the United States, as has the low-temperature distillation of raw solid fuels.

The remarks indicating that oil and gas turbines are approaching a state of commercial practicability may be accepted with reservations by those who know something of the difficulties to be overcome in such developments, but all good engineers are ready and even anxious to be shown.

In view of the fact that engineers of long experience are supposed to be more careful than the younger

men to keep their feet solidly on the ground, some importance must be attached to Mr. Patchell's final statement. "Personally," he says, "I feel convinced that in a short time we shall be seeing all these things as well as the commercial utilization of our lignite and other low-grade fuel stocks as accomplished facts."

Governing the Base Load Turbine

ADJUSTING the unit load so as to obtain the best possible station efficiency has recently led to the more specialized art of adjusting the plant output so as to bring out the maximum possible efficiency of the load-carrying units.

Where several large stations operate in parallel, the most modern one is ordinarily more efficient than those representing earlier practice. This is especially true of conditions at the present time where unusual refinements have been commercially justified. If several stations of different efficiencies are connected with a large system, it is usually advantageous to operate the most modern and efficient station at most suitable load, as far as conditions will permit. Thus the base-load power plant comes into existence and now the base-load turbine is being considered where efficiency is of greater importance than flexibility as characteristic of the usual prime mover.

Governing for maximum efficiency alone brings up a slight departure in engineering practice. Although holding the most economically designed load appears to be of prime importance other factors enter into the problem.

For best results governing should not only maintain the most desirable load, but should hold this without appreciable variation. The average of a widely variable load would require more steam than the same load if constant. The centrifugal governors and valve gears of the present time, which tend to allow prime movers to share load variations in accordance with their respective capacities, are possibly subject to objections from this point of view.

Constant load would require, for best results, constant steam conditions and valve opening. An electrically operated globe valve, which may be adjusted by the control-room operator, would be desirable for preventing load variations. From the practical viewpoint, however, it would be undesirable in case of a generator losing its load suddenly, owing to a circuit breaker opening up or failure of field current to depend on the emergency governor alone. The sudden rush of speed that would occur under such circumstances should be avoided.

The practical answer to the problem is, then, to utilize the usual valve gear in addition to a remote controlled valve. The governor could be set for somewhat higher speed than that of ordinary operation. The main valve element, therefore, would be wide open until a slight overspeed occurred, whereupon the centrifugal governor would exert a closing action.

Where stage bleeding is utilized, efficiency is made somewhat more dependent on constant load. Overload tends to apply higher temperatures to the heaters and lighter loads to cool off the heaters. More condensate in one case and less in the other has somewhat of a balancing effect. There is, nevertheless, a lowering of the efficiency, particularly at lighter loads.

When a turbine designed for 29-in. vacuum, however, is operated at 28-in., the volume of a pound of exhaust steam is about halved. The reduction in velocity of steam leaving the last row of nozzles becomes a serious matter. With normal load, more steam would be required at the lower vacuum, on account of the less available expansion energy. Steam velocities in earlier stages would be consequently increased above normal. It would be desirable to reduce the load when the vacuum falls sufficiently below the designed condition. The base unit load for best results may be subject to a seasonable variation, as depending on condenser conditions.

A large power system does not operate at constant frequency, strictly speaking. Variations range from imperceptible amounts to one or two per cent and sometimes more. The efficiency of a prime mover, however, ordinarily changes very little with a slight difference of speed.

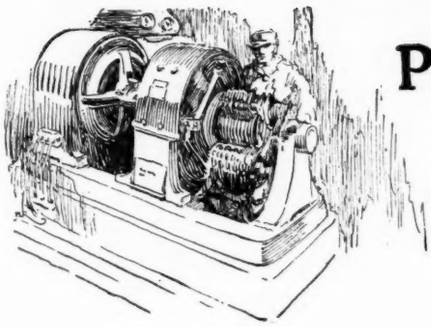
The base-load station of today may be superseded by a more efficient installation of the future, and therefore would then be required to handle more variable loads. This would simply mean a return to the usual operating conditions. Although special difficulties would hardly be anticipated, this probable function should be taken into account in the initial plans.

A Use for Oil Shale

AN IMMENSE amount of research work has been directed toward ways and means of distilling shale for the recovery of the shale oil. There is no gainsaying that there are possibilities in several of the processes developed in the laboratories, but a drawback to the commercial success of shale-oil distillation lies in the fact that the oil recovered must be sold in competition with petroleum oils, such as gasoline and kerosene. The cost of distilling petroleum is much less than that for shale oil, and as long as the supply of petroleum is equal to consumption there is little hope for the shale-oil industry.

There is, however, no reason why the immense deposits of shale should be totally undeveloped. It happens that shale is fairly well distributed throughout the world. Whenever coal is scarce or expensive and a shale bed is available, the shale can be burned in the boiler furnaces with entire success. In Esthonia, a part of old Russia, shale has been used for a number of years under boilers and in house furnaces. The railways made use of thousands of tons, a special furnace with revolving grates being used. Cement mills of that country grind the shale and blow it into the cinder mill. The shale residue, after the oil content is consumed, drops into the clinker and becomes a part of the cement composition.

The Caraway Bill, directing the Federal Power Commission to extend the permit of the Dixie Power Company, which has passed Congress and been signed by the President, is the first case in which Congress has taken action amending the Federal Water Power Act in a specific case. Another bill has been introduced with reference to the Klamath River in California, which if passed, will make the second exception to the law. Regardless of the merits of the particular cases mentioned, if exceptions to the existing law are to be freely made by Congress, it will not be long before the provisions of the Water Power Act, which it required years to bring about, will be rendered ineffective.



Practical Ideas *from* Practical Men

Getting a Step Ahead of the Steam Gage

In practically all boiler plants it is desirable that the recording pressure gage register a good looking steam line. In the first place this is an indication of alertness and attention on the part of the fireman, and in the second place it shows good operation. The economy of steam-driven equipment, where exhaust steam is not used for heating, depends upon having the pressure at the throttle for which it was designed. Often there is little margin between this and the pressure at which the safety valves blow, so the task of keeping up the pressure requires constant watchfulness. A rapidly fluctuating load makes the situation worse, and the penalty for once losing the pressure is the hard, uphill pull to get it back again.

Ordinarily, firemen are guided by the steam gage, although safety valves have sometimes been used for this purpose. The gage may tell whether the pressure is high or low, but it must be watched to know whether it is rising or falling. It is possible to give the fireman this additional or, actually, advance information by means of a device that can be easily constructed from material found around the plant.

To better conditions in the boiler room of a paper mill the lamp signal shown in the illustration was constructed. A brass rod sliding through two wooden supports *A* and *B* is connected to the damper regulator by a chain. Riding on this rod, but free to slide with slight friction, is a brass collar *C* serving as the movable contact. The fixed contacts *D* and *E* are fastened to the supports, but are insulated from the rod by having holes in them large enough to allow the rod to pass through without touching. The electrical connections were made as shown in the illustration.

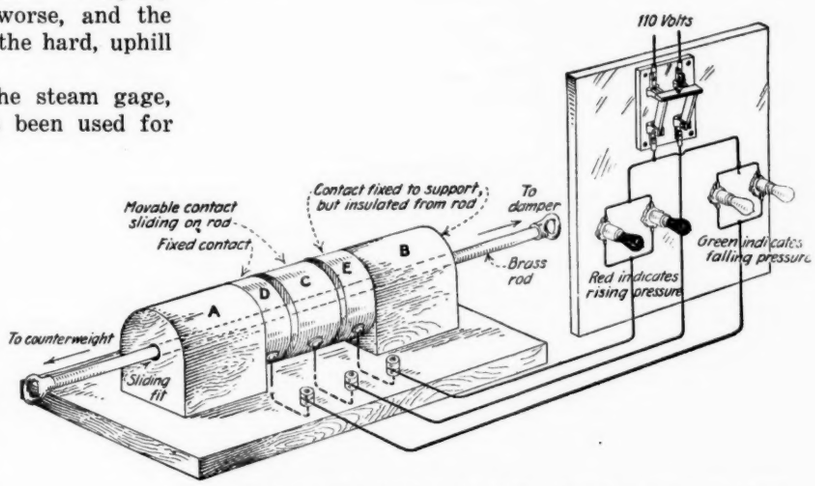
The operation is as follows: Suppose that the pressure is falling. The rod, being drawn to the left by a counterweight, forces the movable contact to complete the circuit, lighting the green lamps. Just as soon as the pressure reaches its lowest point and begins to rise, the circuit will be broken. After a brief interval, during which time the rod will move a distance equal to the small clearance left between the contacts, the red lamps come on.

In this way a fireman can see, sooner than it would be possible to detect any change in the steam gage, that it is no longer necessary to force the fires. By glancing at the lights from time to time, it is much easier to confine the inevitable waves in the line on the chart to comparatively narrow limits.

Such a device would be useful in a boiler plant supplying a dyehouse and steam for engines as well. The sudden increase of load is indicated just enough earlier to give the firemen a better chance to meet it. Furthermore, it is possible to maintain the average pressure somewhat nearer the blowing pressure without danger of the safety valves blowing off.

As it was not desirable to have the lighting circuit grounded, insulators were placed in the chains.

It should be remembered, however, that some damper regulators swing from wide open to closed position without closing little by little as the pressure gradually increases. In such a case this telltale would be of no more value than a pressure gage. Furthermore, if the regulator is out of repair and sluggish, it should be put in good condition before expecting the best results.



Details of telltale and indicating lamp connections

Worcester, Mass. C. F. MERRIAM.

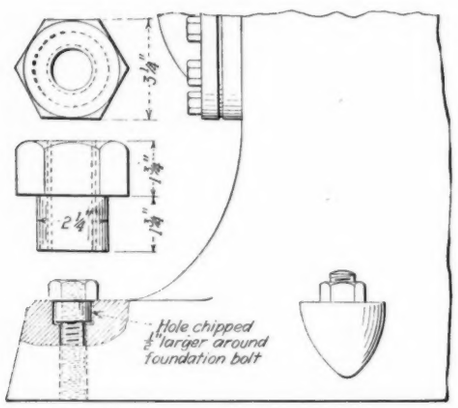
Extension Nuts Used To Repair Broken Foundation Bolts

The illustration shows how we repaired two foundation bolts that broke flush with the top edge of the frame on a 225-ton duplex refrigerating machine, and it may be of interest to those not already familiar with the method, since it enables the repairs to be made without cutting the machine out of service.

The holes were drilled and chipped ½ in. larger around the bolts for a depth of 1¾ in. Two extension nuts were made, as shown in detail and screwed down on the bolts. The machine has been in service for about three months since the repairs were made, and the bolts have remained tight.

It appears that when machines are erected and grouted, the grouting shrinks slightly and after a year or more of service the wedges will have loosened sufficiently to allow the machine to move on the foundation.

Frequently, engineers attempt to tighten the bolts to hold the machine still and the strain eventually breaks the bolts. As a safeguard against breaking the bolts I would suggest that where the old wedges are cov-



Detail and method of using extension nuts

ered in the grouting, recesses be chipped at reasonable distances and, after the bolts are loosened, planed iron wedges be driven under the frame. Then grout around the wedges and tighten up the bolts and the machine will not move.

R. A. HALL.

Macon, Ga.

Attractive Savings in the Industrial Plant

The generation and use of steam in the average industrial plant is so carelessly handled that attractive savings could be made if the management would make it clear to all foremen or departmental heads that they must support the efforts of the steam engineer or efficiency man to save steam and reduce costs. In other words, there must be a firm demand for co-operation from the top of the ladder down to the last man.

It goes without saying that the steam man or power foreman, or whatever title he may have, must not be too optimistic. He should not expect too much in the form of reductions and savings at the outset. Too often a young man, full of enthusiasm, feels that, because he was hired by the general manager or the works manager, he has a clean sweep and can make changes quickly and secure large savings right from the start.

The successful manufacturer usually maintains that his success has been due to foremen that have been with him a great many years, and while he may admit that many of them are not very progressive, yet at the same time when it comes to a show down he will take their word in preference to that of the new power engineer in many cases. Therefore the power engineer should go a little slow first and build a foundation with the foremen or departmental heads; then the savings will come gradually if his policy is constructive.

The field for savings in the steel plant, rubber mill, paper mill, etc., is broad and includes many other things besides steam. In the steel mill it includes the use of blast-furnace gas, coke-oven gas, etc., the selection of coals for boilers and gas producers, the use of coke braize and nut coke to the best advantage, the supply and use of water and compressed air and in some plants the generation and use of power.

In the rubber mill the field is broad and affords many opportunities for savings in the use of steam, air, water and electric power. Besides, there are special problems in heating and the washing and conditioning of air for process work in the mill.

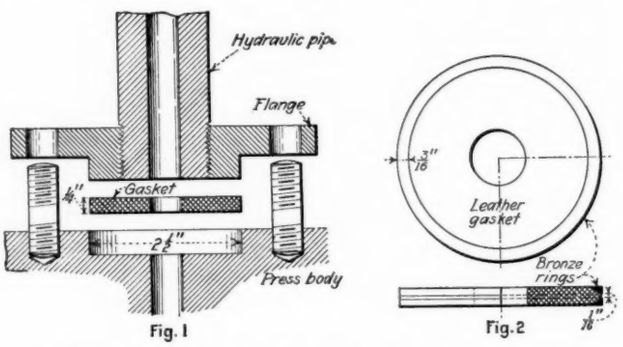
While this is all interesting to the writer, it may be uninteresting to most power engineers or efficiency men, yet the success or failure of the efficiency man in the modern industrial plant depends on his ability to get along well with the foremen of the various departments. The greatest danger to most engineers interested in efficiency work is excessive enthusiasm and optimism. Experience has shown that they are likely to lead to trouble if not tempered down with a thorough study of the manufacturing processes, which study often results in a different view of things.

It is a slogan in some of the large rubber plants "Protect our good name," which to the engineer means, Don't ever take any chances of making changes or savings which may lower the quality of the product.

Tonawanda, N. Y. WALDO WEAVER.

Holding Gaskets in Badly Corroded Seats

In the operation of our hydraulic press trouble was experienced with gaskets blowing out on the water piping to the press. The pipes were connected to the body of the press as shown in Fig. 1. Gaskets of chrome leather were used as packing. This gave good results when the machine was new, but the press was used on material of a corrosive nature, and the seats of the joints soon became rusted out so that there was considerable space between the two parts of the joint, and the pressure (5,000 lb. per sq.in), would force the gasket out into this space. No tools were available for



How gasket was reinforced with bronze rings

cutting out the seats to fit larger flanges, so other means were used to hold the gaskets in place.

Rings of triangular cross-section were turned from bronze, as shown in Fig. 2. These rings were made a snug fit in the seat, and the edges of the gasket were chamfered to fit the rings. The gasket and the two rings were replaced in the seat, and no more trouble was had from the gaskets. In fact, these gaskets have lasted longer than any gasket did when the machine was new, and are still in service.

Manhattan, Kan. D. R. DE TAR.

Comments from Readers

Sulphur as an Index to Ash Fusibility

The results of the study of the fusibility of ash made by Mr. Murray, published in the April 8 issue under "Sulphur as an Index to Ash Fusibility," are interesting and in accord with general experience, as it seems a well-demonstrated fact that most coal ashes are high in silica and that this is fluxed by the iron derived from iron pyrites, in which form most of the sulphur of coals is found.

There is one exception to this rule in the Pocahontas coals, mostly the low-ash coals from the Sewell seam, in which the chief fluxing constituent seems to be lime and in which the fusing temperature increases with increasing sulphur. In all cases the sulphur was under 1 per cent and the fusing temperature under 2,500 deg. F. But the instance is interesting in that it shows how complicated the relationships of the different constituents of the ash are and how little dependence can be put on anything but a fusing-temperature determination on a representative sample or an actual trial under a boiler as a measure of the tendency of a coal to clinker.

New Haven, Conn. H. D. FISHER.

An International Puzzle

The short article, "An International Puzzle," in the April 1 issue of *Power* reviewed the early stages of a discussion recently started in the British magazine, *The Engineer*. This discussion was caused by the publishing of an article by David Brownlie strongly favoring the use of powdered coal, in which article he merely stated briefly what had been accomplished by that method of firing, making no attempt to cover the field of exceptional results obtained in France, the United States and Belgium, where the burning of coal in the powdered form is going forward at a rate that will soon supersede all other methods for the economical utilization of solid fuels and mine waste.

The discussion is not likely to create much international interest because England is backward in adopting powdered coal and her engineers are not qualified to talk on that subject.

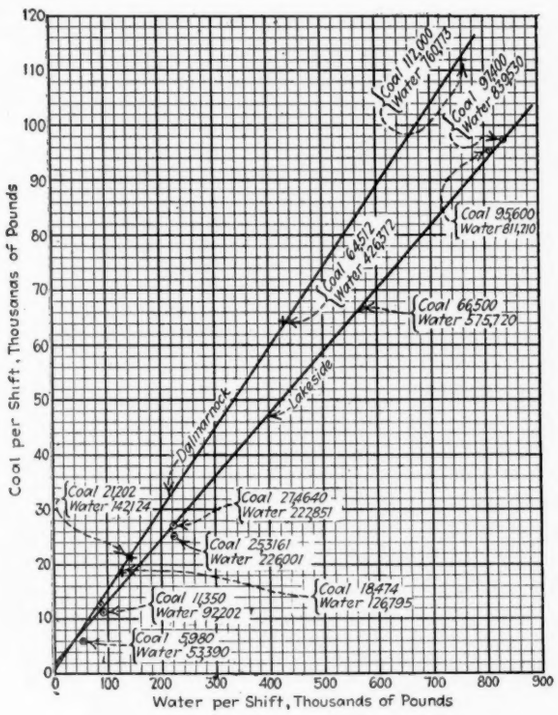
A few months ago, while in England the writer was handed by David Brownlie a proof of the paper he later read before the Institution of Electrical Engineers. This is a detailed consideration of the performance of pulverized fuel as compared with mechanical stoking under the most modern conditions. In this paper will be found the figures shown on the accompanying chart, so that each reader may draw the "Parsons lines" for himself.

Concerning the Parsons lines for the Lakeside Station plotted by Mr. Napier from data taken from the summary of results of five boiler tests with pulverized coal, it would appear that Mr. Napier has made an error.

It seems incredible that the discussion could become an argument between the two gentlemen, Mr. Napier and Mr. Swinton, as to the reliability of the test data obtained at the Lakeside Station, whose over-all efficiency of 85 to 86 per cent had been held up by Mr. Brownlie as sufficient proof of the good results.

The writer has gone over the figures with the best German, French, American, Belgian and British authorities who do not question their authenticity or reliability, but in one or two cases have shown results which apparently are better than those mentioned by Brownlie. These, unfortunately, cannot be published on account of the lack of detailed observations during trials.

In view of the fact that the published results of the Lakeside Station have been broadcast to every country where solid fuel is burned for making steam and, to the writer's knowledge, no adverse criticisms



Parsons lines drawn by the writer

have been made, Mr. Napier should be complimented on his courage in attempting such a discussion.

David Brownlie, in strongly favoring the use of powdered coal (a great step toward fuel economy that will affect the price of everything in Great Britain) has taken the first step toward eliminating the unemployment in his country and placing the nation in the position held before the war. He has been most conservative in his statements and should not be criticized but, if anything, should be knighted for his work.

Hudson, N. Y. J. G. COUTANT.

A Word About Advertising

With reference to the letter by Brother Fagnan in the March 11 issue, page 2, I wish to say that it is the best out. But there is one side of the advertising that is not so easy to put across. Many of us are working for employers who think they know more about our end of the game than we do.

When an engineer sees a piece of equipment advertised in a technical paper and knows that he could make considerable saving for his firm by having one installed, he feels it his duty to take the matter up with his employer and, if possible, get his permission to obtain one. In some cases the boss can be made to see where the article will save money for his firm, while in other cases he can see nothing but the first cost.

It seems to me that the engineer who is in the power plant all day long should be better qualified to make suggestions and improvements than the man who sits in the office and seldom visits the power plant. If the boss would listen more to the engineer, it would in many cases be much to his advantage.

The advertising is there primarily to show how money can be saved for your boss and firm, and the education of the engineer in its use is secondary. If the employers of engineers would or could see this in the proper light, there would be less friction between the boss and the engineer whom he hires to keep the wheels of the plant turning.

Employers have been heard to say that the engineer was only part of the machinery under their charge and should be treated as such. But if the machinery stops for a second, who gets the blame? Certainly not the man in the office.

R. G. SUMMERS.

Rochester, N. Y.

Saving Lubricating Oil

The editorial in the March 4 issue entitled "Saving Lubricating Oil," tempts me to quote a case that came to my notice a few years ago and that may interest *Power* readers.

The engine in question was a vertical four-cylinder single-acting 300-hp. gas engine operating on producer gas (suction-type producers). Forced lubrication was employed, the pump and strainers being situated inside the crankcase, which acted as a reservoir. A gage on the outside of the case indicated the oil level, it being the practice to keep half a glass. The cooling water was supplied to each cylinder independently and passed in series first around the jacket, then through the cylinder head, which was rather intricate in shape and admittedly weak in design. The pistons were of the ordinary air-cooled type.

This engine, during four years' operation had cost the company about $1,800 for new heads alone. They also had a crankcase explosion due to oil vapors, which luckily only blew off one of the crankcase doors. An attempt to maintain full load invariably resulted in preignition. The crankpin bearings kept the repair men busy, and the oil consumption was five gallons of good-quality lubricating oil in eight hours.

Following the crankcase explosion a small fan was belted from a pulley on the end of the crankshaft and supplied air to one end of the crankcase, an exhaust being fitted at the other end. When the engine was running, a dense white oil vapor was forced out into the atmosphere.

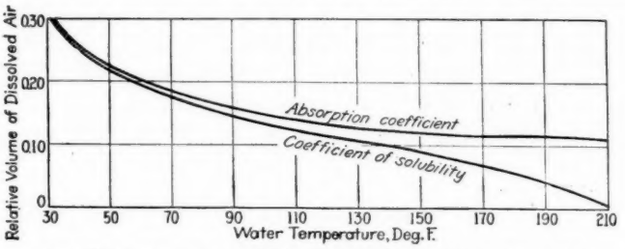
A later examination of the engine revealed a deposit of carbon one-eighth inch thick on the piston heads, with rings gummed up and broken. The carbon on the heads was due apparently to oil drips from the overhead admission-valve stems, the oiling of which had been the engineer's pet hobby. On turning the engine over slowly, it was seen that the crankpin brasses dipped about one inch into the oil in the crankcase, the result when running being a dense spray of oil, which was drawn or thrown up into the piston and liner at each stroke.

These troubles were finally overcome by making the following alterations: The water service was changed to give a parallel supply through heads and jackets, the oil level was lowered about two inches and more economical use of oil on the valve spindles was recommended. These changes eliminated completely the cracking of cylinder heads and preignition became a thing of the past. Practically no further trouble was had with the bearings, and the oil consumption was cut down to one gallon per fifteen hours.

Maldon, England. JAMES F. EDGELL.

Calculating the Amount of Air Liberated in Barometric Condensers

C. M. Reed, in an article in the March 4 issue of *Power*, entitled "Calculating the Amount of Air Liberated in Barometric Condensers," page 370, has made the common mistake of confusing Winkler's absorption coefficients with his coefficients of solubility of different gases in water. The absorption coefficient is the volume



Coefficients of solubility and absorption for air dissolved in water

of gas (reduced to standard temperature and pressure) absorbed by 1 liter of water when the gas pressure is 760 mm. The [corrected] coefficient of solubility is the volume of gas that would be absorbed by 1 liter of water when the total gas and vapor pressure is 760 mm. Mr. Reed's curves are apparently based on the absorption coefficient rather than on the coefficient of solubility.

In a feed-water heater the total pressure is maintained at some approximately constant value. In most heaters such as open heaters, this value is the atmospheric pressure. The air pressure is in these cases equal to the difference between the vapor pressure and the total pressure. The volume of air at standard conditions dissolved in 1 liter of water at any temperature will be equal to the absorption coefficient at that temperature multiplied by the actual air pressure and divided by 29.92 (in case the air pressure is expressed in inches of mercury). When the total pressure is 29.92 in. Hg., the volume of air at standard conditions dissolved in one liter of water is given directly by the coefficient of solubility. The attached figure gives the coefficients of solubility and the absorption coefficient for air dissolved in water.

Figs. 1, 2 and 4 in Mr. Reed's article are in error, since they are based on this erroneous interpretations of Winkler's data. Even if Mr. Reed had used the proper data in calculating these curves, they would not be applicable to a great many feed-water heaters in which there is no relation between the temperature of the water and the oxygen of dissolved air. In a plant with which I am familiar, the feed-water content is less than 0.8 c.c. of oxygen per liter when heated to only 180 deg. F.

I would like to know why Fig. 3 in the article was drawn for air with superheated moisture, as it cannot be imagined how the moisture in air extracted from a jet condenser could be other than saturated.

New Kensington, Pa. HAROLD EDWARDS.

I am greatly interested in the comments made by your correspondent relative to my article in the March 4 issue. It seems, however, that he has approached the problem from the angle of the theoretical physicist rather than from that of the engineer.

From a theoretical point of view his first criticism is entirely justified, since the factors that I used were those which he defines as "absorption coefficients."

From a practical point of view, however, I believe that the use of the "absorption coefficient" is more desirable than that of the true "coefficient of solubility," as it introduces a small factor of safety into the solution of the problem. I do not have before me at this time a table of the true solubility coefficients; however, the effect of using them may be approximated in the following manner:

Assume that cooling water at a temperature of 90 deg. F. is under consideration, also that the amount of air from this source has been determined from Fig. 2 and is called 100 per cent. Taking your correspondent's definition of the solubility coefficient, also remembering that the vapor pressure corresponding to 90 deg. F. is approximately 36 mm. mercury, the true quantity of air will then be $\frac{760 - 36}{760} \times 100 = 95.3$ per cent of that from Fig. 2. This is the extreme case so far as the temperatures considered in my article are concerned. The percentages for the temperatures for which the curves of Fig. 2 were plotted may be tabulated as follows:

PERCENTAGE RATIO OF SOLUBILITY TO ABSORPTION

Temperature of Water, Deg. F.	Vapor Pressure, Mm. Mercury	Ratio, Solubility to Absorption
90	36	0.953
80	26	0.966
70	19	0.975
60	14	0.982
50	9	0.988
40	6	0.992

Taking the examples quoted in item 12, Table I of my article, it will be seen that the percentage of the total air to be removed which comes from the condensing water is 38.1, 45.6 and 60.7 for water temperatures of 60, 70 and 80 deg. respectively. Applying the theoretical correction factors to these percentages, they become 37.4, 44.4 and 58.6 respectively. The greatest difference is with 80 deg. water and amounts to 2.1 per cent of the total. This is a reasonable allowance on the safe side for use in estimating vacuum pump capacity.

Passing to his second criticism, I can again refer to Table I, item 11, from which it will be seen that the air from the steam to be condensed is only from one-third to one-half of one per cent of the total; hence for all practical purposes it may be entirely neglected.

Let me refer your correspondent again to the second, third and fourth paragraphs of my article:

The quantity of air entering with the steam from the boilers will be dependent upon the source of supply, *type of feed-water heater* and the temperature to which the boiler-feed water is heated, *unless the feed water is deaërated before entering the boilers, in which case it should be practically zero.*

The quantity of air liberated from solution in the condensing water depends upon five factors: (1) *The source of supply;* (2) the initial temperature of the water; (3) the final temperature of the water; (4) the absolute condenser pressure; (5) the quantity of condensing water.

. . . These curves . . . represent an air content of 1.98 per cent by volume at 70 deg. F.

A superheated mixture at the air-pump suction will often be found, particularly in case highly superheated steam is being condensed in certain types of counterflow condensers. This I mention as "peculiarities of design" if I remember correctly. Again, if the pump is located some distance from the condenser head and the air pipe passes through a warm building or close to a steam pipe, the mixture will almost always be superheated before it reaches the pump. Therefore, since it is the quantity of air that the pump must handle in which we are interested, it is entirely logical to express this quantity in terms of volume at the pump suction itself, dependent upon pressure and temperature of the mixture at that point.

My paper was prepared after a rather intensive study lasting over a period of about a year, and the methods and curves contained in it were developed to meet the needs of actual conditions with which I came in contact. I must admit that some of them are not often met in the general run of power-plant work, but by publishing them I hoped to be able to save others the worries over supposed impossibilities with which I had to contend until I finally hit upon the solution presented.

Portsmouth, Va. C. M. REED.

Sodium Sulphate Not Alkaline

I wish to direct attention to an error in the editorial entitled "Utilizing Boiler Blow-Down" in the April 1 issue. It is there stated that where water is softened by the soda-lime or similar process, the water entering the boiler will contain large amounts of alkalies such as sodium sulphate. In the first place sodium sulphate does not contribute to the alkalinity of water, as it is not alkaline, although it does contribute to the total solids in solution in the boiler water. In the second place a proper soda-lime system properly operated will produce a satisfactory boiler-feed water (so far as hardness is concerned) with very little alkalinity in the average case. Of course, if an attempt is made to get down below a hardness of 2½ to 3½ grains per gallon, the alkalinity will increase materially. But a total hardness of 3 grains or even 4 grains per gallon will not, in nine cases out of ten, produce any boiler scale, the claims of water-softener people notwithstanding.

It might be said that metal sodium is an alkali. However, as sodium sulphate it does not contribute to alkalinity, and therefore classing it as an alkali in talking of boiler water is misleading to the average engineer, who has trouble enough in keeping straight on what alkalinity, hardness, etc., mean as it is.

G. B. RANDALL,
Chief Engineer, Power Station,
Dayton, Ohio. National Cash Register Co.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Temperatures of Evaporation at Different Vacua

What is the temperature of evaporation of water at different number of inches of vacuum? *H. M.*

The following table gives absolute pressures in inches of mercury at 32 deg. F., absolute pressures in pounds per square inch and temperatures in degrees Fahrenheit for each half-inch of vacuum, 29.5 to 25.5 in., and for each inch, 25 in. to 0 in. referred to a 30-in. barometer and temperature of the mercury 58.4 deg. F.

Vacuum in inches of Mercury, Referred to a 30-In. Bar. (Mercury at 58.4 Deg. F.)	Absolute Pressure in In. of Mercury at 32 Deg. F.	Absolute Pressure in Lb. per Sq. In.	Temperature, Deg. F.	Vacuum in Inches of Mercury, Referred to a 30-In. Bar. (Mercury at 58.4 Deg. F.)	Absolute Pressure in In. of Mercury at 32 Deg. F.	Absolute Pressure in Lb. per Sq.In.	Temperature, Deg. F.
29.5	0.498	0.244	58.77	16.0	13.96	6.84	175.93
29.0	0.997	0.488	79.07	15.0	14.95	7.32	179.03
28.5	1.495	0.732	91.70	14.0	15.95	7.81	181.92
28.0	1.994	0.977	101.15	13.0	16.95	8.30	184.68
27.5	2.493	1.221	108.70	12.0	17.95	8.79	187.31
27.0	2.991	1.465	115.06	11.0	18.94	9.28	189.83
26.5	3.490	1.710	120.55	10.0	19.94	9.77	192.23
26.0	3.989	1.954	125.38	9.0	20.94	10.26	194.52
25.5	4.487	2.198	129.75	8.0	21.94	10.75	196.73
25.0	4.98	2.44	137.77	7.0	22.93	11.23	198.87
24.0	5.98	2.93	140.64	6.0	23.93	11.72	200.94
23.0	6.98	3.42	146.78	5.0	24.93	12.21	202.92
22.0	7.97	3.90	152.16	4.0	25.92	12.70	204.85
21.0	8.97	4.39	157.00	3.0	26.92	13.19	206.71
20.0	9.97	4.88	161.42	2.0	27.92	13.68	208.52
19.0	10.97	5.37	165.42	1.0	28.92	14.17	210.28
18.0	11.96	5.86	169.14	*0.0	29.92	14.67	212.00
17.0	12.96	6.35	172.63				

* Zero vacuum is atmospheric pressure or 14.7 lb. absolute.

Coal Consumption for Operation of Steam Jets

Each of our boilers is equipped with a smoke-consumer nozzle having six ⅛-in. diameter holes supplied with steam at 120 lb. gage pressure. What quantity of coal is required to make steam used by each nozzle? *S. L.*

It is understood that the pressure 120 lb. per sq.in. is maintained in the nozzle. The quantity of steam discharged by each ⅛-in. diameter aperture is given by Napier's approximate rule, namely:

Flow in pounds per second = absolute pressure × area in square inches ÷ 70

As each ⅛-in. diameter aperature would have an area of 0.01227 sq.in., and 120 lb. gage pressure would be equal to 120 + 15 = 135 lb. per sq.in. absolute, the quantity of steam discharged by each nozzle with six ⅛-in. diameter apertures would be 6 × 135 × 0.01227 ÷ 70 = 0.142 lb. of steam per second, or 511 lb. of steam per hour.

The quantity of coal required per hour would depend on the number of pounds of water evaporated per pound of coal. Assuming that the boiler evaporates 8 lb. of water per pound of coal, the coal consumption required for the operation of one nozzle with six ⅛-in. diameter apertures would be 511 ÷ 8 = about 64 lb. of coal per hour.

Feed Pump Steambound with Highest Feed-Water Temperature

My feed pump becomes steambound when the feed-water temperature is highest. How may I operate the pump without lowering the temperature of the feed water? *M. W.*

The pump becomes steambound when the suction pressure in the pump is lower than the pressure that corresponds with the temperature of evaporation. This occurs when some of the suction water just before or upon reaching the pump bursts into vapor and fills the whole or part of the pump cylinder with steam to the exclusion of additional suction water.

The suction pressure will be higher and the pump will be less likely to become steambound if higher water level is carried in the heater, or if loss of pressure from pipe friction in the suction line is reduced by running the pump slower, or by increasing the size and reducing the length and number of bends in the suction pipe from the heater. If the suction pressure at the pump cannot be thus sufficiently increased to prevent the pump from becoming steambound when the heater raises the water to the highest temperature, the necessary suction pressure must be obtained by having the pump at lower elevation with respect to the water level carried in the heater.

Current Taken by Induction Motors

Does the current of an induction motor depend on the power factor of the supply circuit? When the manufacturers of an induction motor give the amperes per phase on the name-plate, what is this statement based on? When a sales contract specifies a certain power factor for an induction motor, is this based on a line circuit as unity power factor? If a power factor of 0.90 is specified for an induction motor and the power factor of the line is, say, 0.85, what will be the power factor of the system? What is usually the power factor of the line current supplied from modern central stations? *J. B.*

The full-load current of an induction motor will depend upon the speed of the motor and its rating in horsepower. A high-speed motor has a better power factor than one of low speed. For example, a 10-hp. 3,450-r.p.m. 60-cycle 440-volt squirrel-gage induction motor at one-half load will have a power factor of about 0.87 and at full load a power factor of 0.93. The

same type of motor operating at 575 r.p.m. will have a power factor of about 0.58 at half load and 0.78 at full load. The efficiency of the high-speed motor will be 3 or 4 per cent better than that of the slow-speed motor, which will also affect the full-load current of the machine.

The current taken by a three-phase motor is equal to (746 × *horsepower*) ÷ (*voltage* × *efficiency* × *power factor* × 1.732). Taking the full-load efficiency of the high-speed motor at 0.90 and that for the slow-speed motor at 0.86, the full-load current for the high-speed machine will be equal to (746 × 10) ÷ (440 × 0.90 × 0.93 × 1.732) = 11.7 amperes. For the slow-speed motor the full-load current will equal (746 × 10) ÷ (440 × 0.86 × 0.78 × 1.732) = 14.6 amperes, or a difference of 2.9 amperes taken by the slow-speed over that of the high-speed machine.

The current rating given on the name-plate of a motor is the full-load current of the machine. The power factor specified for a motor is that of the machine at full load. At less than full load the power factor will be lower, depending upon the design of the machine. For example, in the two motors referred to, the power factor of the high-speed machine drops from 0.93 to 0.87 from full load to half load, and on the slow-speed machine it drops from 0.78 to 0.58 from full load to half load.

The power factor of the line to which the motor is connected has nothing to do with the power factor of the motor, except in so far as the power factor of the line might influence the voltage regulation of the system, which would be small in the average installation.

If the motor has a power factor of 0.90 and is connected to a line having a power factor of 0.85, the resultant power factor of the load will be somewhere between 0.85 and 0.90, depending upon the relation of the motor load to the load already on the system. If the motor load is large compared to that on the line, then the power factor will be increased to near 0.90. If the line load is large compared to the motor load, the resultant power factor on the line will be slightly above 0.85.

The power generating equipment has nothing to do with the power factor of the system. This power factor is established by the connected load. If the load consists of induction motors which are lightly loaded, the power factor will be low. On the other hand, if the load consists of induction motors that are well loaded and also some synchronous or synchronous-induction motors, the power factor will be high.

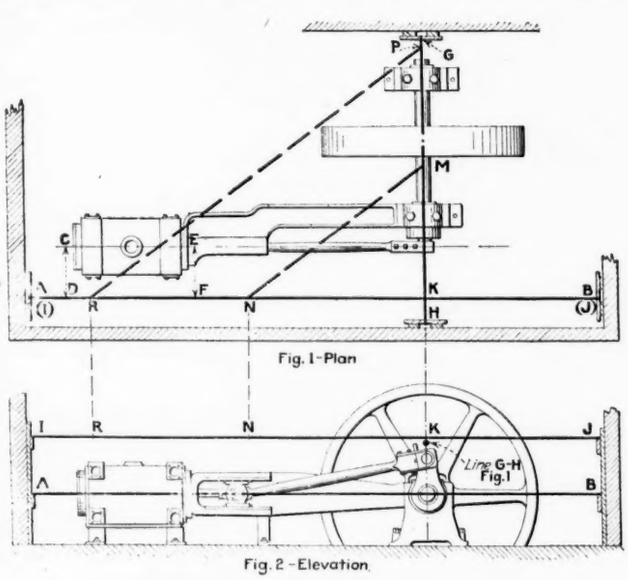
Lining Engine Shaft Square with Cylinder Center Line

How can an engine shaft be lined up square with the cylinder center line without removing the piston from the cylinder? *R. L. B.*

Set an offset line *AB*, Figs. 1 and 2, on one side of the cylinder as a reference line which will be parallel with the cylinder center line. For this purpose remove the cylinder head, place a strip of wood across the cylinder counterbore, on it locate the center of the counterbore and adjust the ends of a line *AB*, Figs. 1 and 2, to make it level with the center of the counterbore and center of the piston-rod stuffing box and take equal offset distances *CD* and *EF*, Fig. 1, to one side of the cylinder center line. Next level up the shaft by adjusting the height of the outboard bearing and stretch a line *GH* approximately level and located over the center of the shaft by taking half of the distance between plumblines held up to each side of the shaft near the main bearing and near the outboard bearing. Next stretch another line *IJ* plumb over *AB*, almost touching *GH* at *K*, and have the ends of the line at the same level. The line *IJ* then will be in a vertical plane parallel with the cylinder center line; *GH* will be in the same vertical plane as the center line of the shaft, and as these lines will be nearly in the same horizontal plane, the angle *GKA*, Fig. 1, can be tested to determine whether the vertical plane through the shaft is at right angles to the vertical plane through *IJ* and *AB*, and the vertical plane through the center line of the cylinder.

Then from *K* on the line *GH* lay off *KM* any convenient distance and locate a point *N* on the line *IJ*, making *KN* equal to 1½ times *KM*.

If *MK* is square with *KN*, the distance *NM* will be equal to 1⅝ times *KM*, since for *MKN* to be a right-angle triangle *MK*, *KN* and *MN* would be in the proportion of 3, 4 and 5; or by laying off any other distance *KP* and making *KR* equal to 1½ times *KP*, then *RP* should be equal to 1⅝ times *KP*. If the hypothenuse *NM* or *RP* is found to be too short to satisfy the proportions of 3, 4 and 5 in either case, the end *G* of the line *GH* must be moved farther away from the cylinder of the engine; or if found too great, the end *G* must be moved nearer the cylinder of the engine and measurements and adjustments must be repeated until the correct length of hypothenuse *NM* or *RP* is obtained.



Lining up engine from offset center line

When this is done, plumb on both sides of the shaft close to the main bearing and determine how much the line *GH* would have to be moved to bring it over the center of the shaft at the main bearing; then move both ends of the line that amount horizontally in the same direction, and set the outboard bearing so the shaft will be level and centrally under the line *GH*.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Stopping Radiation Losses

WITH all the facts available concerning the losses from heated surfaces—facts upon which there is substantial agreement throughout the engineering profession—it is hard to understand how any operating engineer or owner could be content to leave steam pipes and similar surfaces uncovered or improperly insulated. Yet this condition exists in many places even today. It is not at all uncommon to find plants with several hundred feet of steam piping completely bare and with other sections whose "insulation" hangs on in patches.

Common Excuses Will Not Stand Investigation

Sometimes the excuse is made that the line will be in use only for a year or two or that money is lacking for non-essentials. Those making such statements evidently do not have a full appreciation of the situation. Depending somewhat on steam temperature, cost of coal and other conditions, the statement can be made that a first-class job of heat insulation on steam-heated surfaces will pay for itself in from two to six months in fuel saved. Evidently, then, the "temporary-line-only" argument falls down if the line is to be used for a longer period than this. The "lack-of-money" argument holds water only where the company is in such bad shape that it cannot finance itself even for a few months. If for example, the installation will pay for itself in five months (a conservative average), it is obvious that the company will actually have the same amount of cash on hand at the end of five months whether it installs the covering or not. Thereafter, with the first cost entirely eliminated, the insulating will go on returning a yearly dividend of 240 per cent on the investment.

Figuring Time Required for Job To Pay for Itself

To figure the time required for a job of heat insulation to pay for itself, two things must be known—the cost of the job installed and the obtainable saving in dollars per day.

If the job is to be done by contract, the former item is easily obtainable as the amount of the bid. If, on the other hand, the plant force is to apply the insulation, the price of the necessary materials can be obtained from the manufacturer and increased by the estimated cost of labor. Where data for estimating the amount of labor required for erection are lacking, the manufacturer can tell about what percentage of the cost of the material should be added to cover this item.

In figuring the saving the first step is to prepare a form with headings similar to those shown in the table. For simplicity the fittings and flanges have not been considered, as most of the loss is from the piping.

Recording Data and Results in Systematic Form

The first step is to make a tour of the plant with a six-foot rule or tape and jot down the sizes and lengths of sections that need covering. Notes of steam pressure and superheat and water temperature (in feed lines) are made at the same time. These are then totaled for each size of pipe and each condition. After referring to the steam tables for the temperature corresponding to various pressures and degrees of superheat, columns *A*, *B* and *C* can be filled out directly.

In column *D*, for the bare pipe loss per running foot, it has not been specified in what unit this loss is to be measured. Among the possible units are the following: B.t.u. per hour; pounds of steam condensed per hour; tons of coal per day or per month. The unit adopted must depend upon the nature of the tables available for the losses from bare pipes and the savings from insulation. More will be said of this later.

FORM FOR COMPUTING SAVINGS

A Size of pipe	*B* Length of pipe	*C* Inside temperature	*D* Loss per running foot, bare	*E* Total loss, bare	*F* Kind and thickness of covering	*G* Per cent saving	*H* Total saving

Factors Influencing Kind and Thickness of Covering

Whatever unit is used in column *D*, column *E* is obtained by multiplying column *D* by column *B*. Column *F* is then filled in with the kind and thickness of insulation decided upon for the given pipe size and conditions.

Many factors influence the choice of the kind of insulation. In power-plant work it is generally worth while to consider only the better grades. These usually vary but little in efficiency, so that the final choice is largely a matter of personal preference based on the experience of the engineer and his friends with various types of insulation.

The correct thickness involves even more factors and is best determined by reference to tables prepared by the manufacturers for various sets of conditions. The most economical thickness increases with the size of the pipe, the steam temperature, the cost of coal, the number of hours per day during which steam is in the pipe and the probable life of the installation. On the other hand, it decreases with increase in the unit cost of the material and the efficiency of the boiler plant.

The tables are prepared on the basis of the economic law that the thickness of the covering should be increased up to the point where the additional saving by any further increase in thickness would not give a fair return on the additional money invested. It is obvious that higher coal cost, steam temperature and an increased percentage of time under steam warrant thicker covering.

The chief reason that small pipes do not warrant such thick covering as large ones is that the cost of covering per square foot surface is greater for a small pipe than for the same thickness on a large pipe. At the same time the saving is less. This is due to the fact that as the thickness of covering on a small pipe is increased the outer circumference increases very rapidly, which increases the amount of insulating material required and at the same time gives a larger area for the escape of heat. Higher boiler efficiency, on the other hand, means that less coal is burned to produce the amount of heat saved at the pipe. However, within the customary limits of boiler efficiency, this variation is not of great importance.

Computing the Final Saving in Dollars

If the tables give the percentage saving, this may be entered directly in column *G*. Then the figures in column *G* multiplied by those in column *E* will give the total saving in column *H*. After totaling column *H*, it must be reduced to a dollars-and-cents basis. If expressed in pounds of steam or B.t.u., the equivalent weight of coal can be computed quickly. In this connection it must be remembered that if the boiler efficiency is, say, 70 per cent and the coal has 13,000 B.t.u. per pound, each pound will produce at the pipe only $13{,}000 \times 0.70 = 9{,}100$ B.t.u. The saving will then be the product of the number of tons of coal saved by the cost per ton of the coal delivered at the plant plus the cost of handling and firing one ton of coal and of disposing of its ash.

While the greater cost, per square foot of surface, for insulating fittings and flanges results in a smaller return on the investment than with the straight pipe covering, the return is still considerable, and such insulation will generally pay for itself in two or three years. The extra cost of providing removable flange covers may be warranted where the necessity for tightening flange bolts or replacing gaskets is likely to arise.

New and Improved Equipment

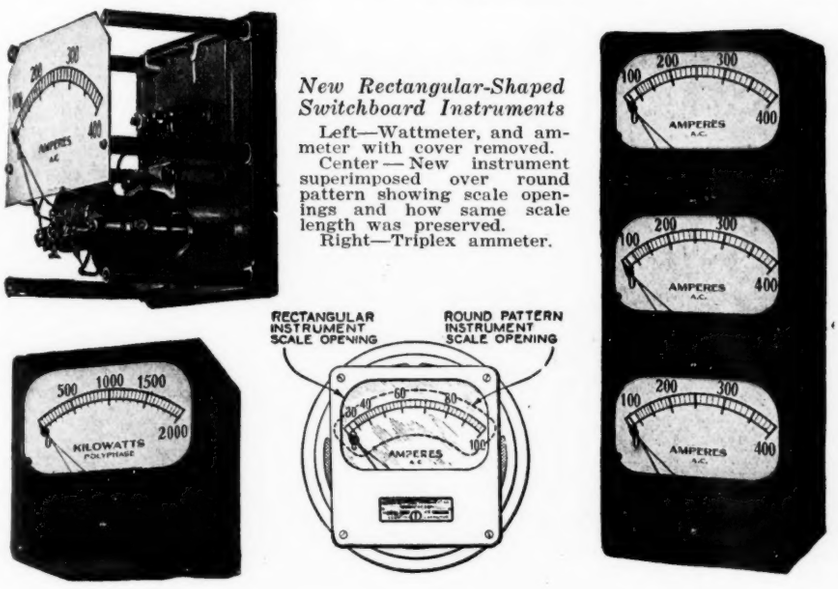
Rectangular Type of Switchboard Instruments

Economy in space on the switchboard becomes of greater importance with the increase in the size of power system and the tendency to obtain more complete record of operation. It is also desirable in so far as possible to concentrate all the meters and protective equipment on one panel where possible, so that the operator may have available all information on any one machine or circuit, in one location. In large stations the space taken by the switchboard is becoming a factor of increasing importance in the layout of the plant.

To keep the space taken by the instruments on the switchboard at a minimum and yet provide a standard scale reading, a new line of electrical instruments has been brought out by the Weston Electrical Instrument Co., Newark, N. J. The meters are rectangular in shape and include direct-current voltmeters and ammeters and alternating-current meters for use on switchboards.

All the instruments of the group have uniform case size dimensions—5¾ in. wide and 6 in. high. This affords a remarkable saving in space which has been attained without sacrificing any of the essential characteristics of the round-pattern instruments. In the case of the rectangular instrument four may be laterally accommodated on a 24-in. panel, whereas the round pattern instruments require a 32-in. panel and a greater vertical space. The ratio of space is approximately five to nine in favor of the rectangular case. A triplex ammeter, as shown in the illustration, contributes to the saving in space where an ammeter is required in each phase.

Although the new instruments occupy a much smaller space, reference to the cut shows how it was possible to preserve the same scale length as in the round-pattern instruments. Further, there has been obtained a much larger scale opening, permitting better illumination and improved legibility, which is also facilitated by larger and heavier scale numerals printed on a horizontal plane. The wiring studs in the rear of the instrument have been grouped in the center and have been kept uniform on all types, so that any instrument with an equal or lesser number of studs than another can replace it without requiring new drilling. Resistors, where used, are mounted back of the switchboard on studs projecting from the rear of the instrument. These resistors have also been made correspondingly smaller.



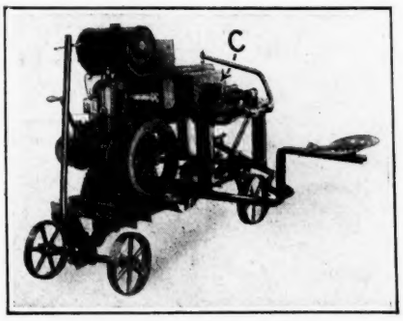
New Rectangular-Shaped Switchboard Instruments

Left—Wattmeter, and ammeter with cover removed.
Center—New instrument superimposed over round pattern showing scale openings and how same scale length was preserved.
Right—Triplex ammeter.

Maroa Brick-Cleaning Machine

In the accompanying photograph is shown a portable machine that has been designed by the Maroa Manufacturing Co., of Maroa, Ill., to remove the mortar from used brick. In rebuilding boiler settings and furnaces, the machine should have its uses in the power plant. The outfit is 5 ft. long, 3 ft. wide, 3 ft. high over-all and weighs about 550 lb. It may be driven by a 5-hp. air-cooled engine, a 4-hp. water-cooled radiator-type engine, or an electric motor.

The principle of operation is much the same as that of a multiple set of drills working together, with the cutters overlapping so that the entire surface of the brick may be cleaned. The various cutters *C* of a unit rotate in opposite directions, being driven by intermeshing steel cut gears running in transmission grease. They are made of the hardest metal that can be secured, a composition of manganese and chrome white iron. Special types of cutters are supplied for concrete and other hard mortars.



Brick-cleaning machine

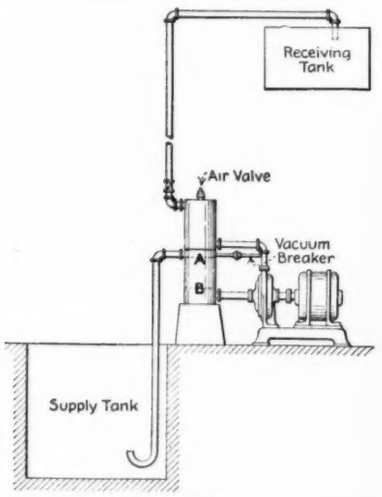
The machine is designed to clean one side of the brick at a time. When cleaning the four sides, the foot-operated device is used to hold the brick against the cutters. The ends are cleaned by holding the end of the brick by the side of the foot plate and pressing it against the cutters by hand. A considerable saving is claimed on broken brick and in wages over hand cleaning. The replacement cost of cutters has averaged about ten cents per thousand bricks.

Automatic Primer for Centrifugal Pumps

The Apco primer illustrated in the accompanying sketch is designed to prime centrifugal pumps automatically on suction lifts. It consists of two tanks, one placed above the other. For the initial operation the lower tank is filled with liquid up to level *A*. When the pump is started, the level is lowered to *B* and a vacuum is produced which insures a flow from the supply tank through the suction line. The discharge from the pump enters the bottom of the upper tank and passes out at the top into the receiving tank. When the pump is stopped, the air valve on the top of the upper tank opens and allows the water to flow by gravity through the pump and up in the lower tank to the level *A*, which is above the top of the pump casing. This action forces the air back through the suction line and reprimes the system so that the pump may be started as before.

When the flow of water is reversed, there is a siphoning action that must be broken up to prevent an air pocket forming in the pump and interfering with the starting operation. To prevent such a contingency, a vacuum breaker is introduced between the discharge line of the pump and the upper portion of the lower tank. As soon as the water drops below the point of connection to the discharge line, air is introduced through the vacuum breaker into the lower tank and the original equilibrium is restored.

To prevent air binding of the lower priming tank, the suction connection has been made at the top so that the entering water, in falling through the air trapped in the tank, will entrain more than sufficient air to compensate for any air or vapor that might be released from the water when it is



Arrangement of primer connections

placed under vacuum. Air passed by the pump should collect at the top of the upper tank and escape through the air valve, thus obviating air pockets in the discharge line.

The primer is made in a wide variety of standard sizes for suction-pipe diameters ranging from 1 to 10 in. It is built to withstand a maximum working pressure of 50 lb., although primers may be specially built for higher pressures. The Automatic Primer Co., 111 West Washington St., Chicago, supplies this equipment.

"Ideal" Forced-Draft Stoker for Small Boilers

A simple forced-draft stoker for application to small power-plant boilers and low-pressure heating installations has been developed by Joseph Harrington, 650 Old Colony Bldg., Chicago. The stoker is designed substantially as follows: Cast-iron side frames support all transverse members between them, with the operating equipment on one side and the forced-blast fan on the other side. These are attached directly to the exterior of the side frames, forward of the boiler front, so that the entire stoker is a self-contained unit, there being nothing put into the brickwork other than an inspection door at the side, which is little more than a peephole.

Forming the base of the coal hopper there is a reciprocating plate carried on roller bearings, which is driven from the motor and has a travel of 0 to 5 in. The first set of grate bars are attached to the rear of this plate, the rear ends of the bars resting upon and sliding over the second step of the grate, which is formed of a series of stationary grate bars. Below and to the rear of the stationary grate is the third step, which is also movable. It has a motion synchronizing with the feed plate, which may be adjusted in extent from zero up to 4 in. The rear end of this section rests on a second stationary step, which is the fourth and last one in the stoker. The final support is a water-cooled rear cross-girder over which the ash flows through the opening to the pit.

A distinctive feature of the stoker having a bearing on the results obtained is the use of a plate or table directly under the ash opening at the

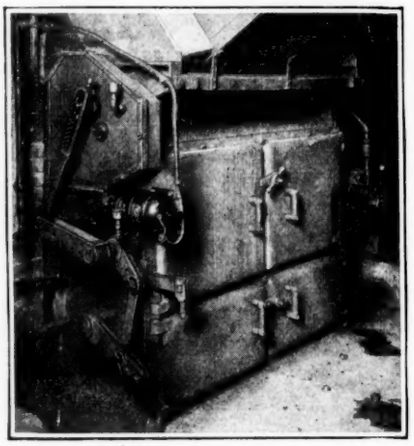


Fig. 1—Stoker front, showing drive

rear, so placed that it supports the body of ash as it falls from the stoker. This plate is given a reciprocating motion, causing a slow but definite travel of the ash toward the front, but at all times filling the throat or ash opening so as to seal it against an inrush of cold air.

To insure against the formation of side-wall clinkers, water-cooled sides connected into the boiler circulation are provided. These side pieces consist of steel pipes surrounded by cast iron, with a blowoff to blow them down occasionally as required.

With alternating current a constant-speed motor is used to drive the stoker, speed variations being effected through a simple mechanical variator which controls the length of the feed stroke. Where direct current is available, a variable-speed direct-current motor may be used.

Draft may be supplied by either a turbo-blower or a motor-driven blower, or, at low loads the front doors may be thrown open and the stoker operated under natural draft. The stoker will be built to give effective grate widths ranging from 1 to 7 ft., and areas from 4 to 45 sq.ft. One of these stokers is in operation under a 1,500 sq.ft. horizontal return-tubular boiler in Chicago, and the results obtained seem to guarantee the substantial success of the design. In this instance the stoker is 5 ft. wide by 6½ ft. long, giving a total effective grate area of 32.5 sq.ft. Approximately 1,200 lb. of Southern Illinois screenings are burned per hour therein, producing a combustion rate per square foot of 37 lb.

To secure the necessary draft for this rate of combustion, a turbo-blower is attached to the stoker and produces approximately ½-in. pressure in the compartment below the grate surface. The boiler is set 5 ft. 9 in. above the floor line and the stoker flush with the boiler front, only the hopper and operating motor projecting forward of the front line of the boiler. It will be noticed that a fuel consumption of 1,200 lb. at the fair efficiency indicated by the operating conditions, figures out about 300 hp., or double the nominal rating of the boiler. The boiler appears to carry this load satisfactorily and with no appreciable brickwork deterioration.

During this period samples of coal and ash were taken and the gas regularly analyzed. Franklin County screenings of the following analysis figured to the dry basis were used: Ash, 11.39; volatile, 35.66; fixed carbon, 52.95; B.t.u., 12,910; sulphur, 2.48. The ash resulting from this run analyzed: Dry ash, 83.30, and combustible, 16.70, showing a pit loss of 1.9 per cent.

Determinations were made every fifteen minutes for an entire day, giving an average of 14 per cent CO_2. Smoke observations showed a clear stack.

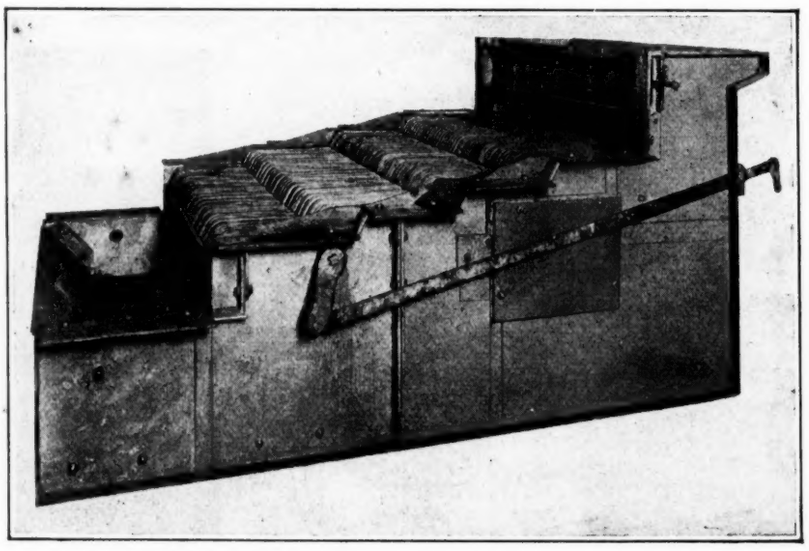


Fig. 2—Showing stoker as self-contained unit independent of the furnace brickwork

Recent Developments in Hydro-Electric Equipment

IN A paper presented at the Spring convention of the American Institute of Electrical Engineers, held in Birmingham, Ala., April 7 to 11, 1924, William M. White, manager and chief engineer of the Allis-Chalmers Manufacturing Co., after giving a brief description of a number of large modern hydro-electric installations, said in part:

Concrete Spiral Casings

The design of the concrete spiral-casing type of machine has received its share of attention and much time and thought have been expended in improving and simplifying their construction. The writer is in favor of placing the nose of the casing even with, or downstream from, the center line at the side of the unit. This shortens the path of the water, enables the units to be placed closer together and provides additional thickness in the separating walls between the units, where it is most needed. Great care must be exercised in constructing the concrete spiral casing, and a large amount of reinforcing steel must be used to strengthen it properly, especially above 60-ft. head. For this reason the writer has long recommended the use of the plate-steel spiral casing for heads as low as 50 ft. For normal settings very little more steel is required to build the spiral casing than is used for the reinforcing of the concrete spirals. It can be readily put together in the field and mass concrete poured around it, doing away entirely with the complicated wooden forms, which must be built by expert carpenters or patternmakers. Since the plate-steel casings are entirely self-supporting, they may be left practically uncovered. They may be set one almost touching the other, thus decreasing the power-house length and doing away with the heavy concrete dividing wall which is necessary with the concrete spiral setting to obtain sufficient strength in case one unit is drained while an adjacent one is in operation.

Plate-Steel Spiral Casings

Plate-steel spiral casings have been constructed for heads as low as 30 ft. A record was probably established for high-head plate-steel spirals during the last year in those built for the New England Power Co., Davis Bridge Plant, developing 19,500 hp. each under 345-ft. head.

A striking example of the use of the plate-steel spiral casing for medium heads is the 20,000-hp. unit for the West Kootenay Power & Light Co. to operate under 70-ft. head. In this case the saving by shortening the distance between the center lines of units, thus decreasing the amount of excavation in the solid rock required for the power house, practically paid for the additional cost of the plate-steel casing, not taking into account the saving in reinforcing steel and labor in building the forms and constructing the concrete casing.

In the high-head field, undoubtedly, a new record has been established in using a Francis type of turbine for 850-ft. head, these being the Oak Grove turbines of the Portland Railway, Light & Power Company now being constructed by the Pelton Water-Wheel Co. They will use the Moody type of draft tube and rubber sealing rings on the runner and guide vanes.

Impulse turbines have apparently established no new records during the past season, although an additional 30,000-hp. turbine is now being installed in the Caribou plant of the Great Western Power Co. This is the world's record both for horsepower and size of machine, for this type of unit. Experiments conducted in the hydraulic laboratory of the Allis-Chalmers Manufacturing Co. upon several different designs of buckets and impulse-wheel settings, have proved conclusively that the efficiency of a well-designed impulse unit compares favorably with that of the best type of Francis wheel and even surpasses it at part gate.

No radical changes have been made in the fundamental features of hydraulic-turbine governors during the last ten years, although many improvements have been made with the view of simplifying and making this equipment more reliable. The governor equipment for the 70,000-hp. Niagara Falls turbine is similar to that used with the 37,500-hp. units installed in 1919. The flyballs are mounted directly on the mainshaft, and their motion is transmitted to the governor stand located on the upper generator floor. A large number of plants have been placed in operation, using a motor to drive the flyballs, thus doing away with jackshafts and belts. Fairly satisfactory results have been obtained, although there is always danger of losing the driving current in case of trouble with the generator, in which event the turbine gates will open wide instead of closing. To eliminate this danger, a small independent generator mounted on the waterwheel shaft, driving only the flyball motor, would be ideal, but the cost makes it prohibitive for general use.

In the large power systems existing at the present time, the instantaneous load fluctuations reach such a small percentage of the total output of the system, that there is little actual work for a governor. Their existence is justified only as a safety device, for in case of electrical trouble they will shut the machine down quickly. An interesting development has been the installation of several hydro-electric units not equipped with governors. The generators and oiling systems were designed to withstand prolonged runaway, the units delivering current into a fairly large power system, and regulation being provided by the governor-equipped units in other stations on the system. Sufficient leeway is maintained in the governor-equipped station to pick up any rapid increase in load, slow fluctuations being controlled by manual adjustment of the units not equipped with governors. The three 5,500-hp., 65-ft. head, vertical units of the Brown Co. at Berlin, N. H., are the best examples of a complete installation without governors.

PLATE-STEEL spiral casings have been used for heads as low as 30 ft. and up to heads of 345 ft. In high-head plants a new record has been established for Francis type turbines in one now being constructed for 850-ft. effective head. Tests have proved that the efficiency of a well-designed impulse unit compares favorably with that of the best type of Francis wheel and even surpasses it at part gate. On large hydro-electric systems it is becoming the practice to install part of the waterwheels without governors.

Automatic-Control Equipment

Automatic-control equipment for hydro-electric installation has drawn more and more attention during the past few years. The emergency-stop device is a safety feature that is being used on nearly all of the large installations made by the Allis-Chalmers Manufacturing Co., and enables the operator at the switchboard to shut the turbine gates and stop the machine quickly without requiring the assistance of the second or third operator. This is accomplished by closing a switch on the switchboard, energizing a solenoid mounted on the governor stand, which immediately causes the pilot valve to be lifted into the closed position and held there, thus bringing the turbine gates to the full closed position in the minimum time allowable. This emergency-stop device may also be connected to temperature indicators in the turbine or generator bearings, or generator windings, to overload or differential relays, or any other recording or indicating device used to indicate abnormal conditions.

Remote-Control Equipment

Remote-control equipment is designed to be used with large units where it is especially desirable to have the machine under the direct control of the switchboard operator, even during starting up and stopping, instead of having the second operator start the machine and bring it up to speed by hand as is the common custom. By means of the electrically operated synchronizing device and remote-control load-limiting device the switchboard operator may open the gates slowly and bring the unit up to speed from dead stop, indicating instruments on the switchboard showing him at all times the exact position of the turbine gates and the load-limit setting. With this equipment it is not necessary for the second attendant to touch the governor, and the unit may be separated from the line, shut down completely and the brakes applied by the switchboard operator. This same equipment may be used for controlling a distant unit from another station, although it will require more connecting wires between the two stations than with the full automatic control equipment.

Possibility of Dynamic Back-Pressure Reduction in Reciprocating Steam and Gas Engines*

BY F. LOEWENBERG†

RECIPROCATING steam engines do not expand the working medium down to back pressure. Considerations of weight and size bring it about that the cylinder pressure at the time the exhaust begins is considerably higher than the back pressure and the loss due to incomplete expansion constitutes the main disadvantage of the reciprocating engine compared to the turbine. Attempts have been made to improve indirectly the efficiency of the reciprocating engine by utilizing the energy of the exhaust steam in auxiliary turbines, but a more promising way and one that is mechanically simpler consists in producing in the cylinder a pressure lower than the back pressure by using the otherwise lost energy of the exhaust steam or gas.

Suggested Methods

This result may be accomplished in two ways. One method, applicable to multi-cylinder engines with overlapping exhaust periods, relies on the well-known characteristics of fluid jets, as made use of in injectors and similar apparatus. It consists of suitable exhaust-pipe arrangements to obtain an ejector action, the exhaust of one cylinder producing a sucking action on the contents of one of the other cylinders.

The second method is based on the inertia of moving fluid columns and is applicable to single-cylinder engines or engines with no overlap of exhaust periods. It has been found, in connection with experiments on the propagation of explosion waves, that the high-pressure part of the wave is followed by a period of low pressure, a phenomenon that also applies to the unloading of steam- and gas-engine cylinders. By properly proportioning the exhaust pipe, it is possible to time the low-pressure period so that it coincides with the closing of the exhaust port in a unaflow engine, with a corresponding reduction in back pressure.

Energy in Exhaust

In cases of back-pressure reduction by means of ejector action the question arises, How much energy is available in the exhaust steam and how much energy is required to produce a certain vacuum and to maintain it up to the time the exhaust port or ports are being closed?

For an example, a gas-engine cylinder may be assumed with a bore of 4 in., a stroke of 6 in., a compression space of 32 per cent and with 14.6 per cent exhaust release. With a pressure of 75 lb. absolute at release the energy available in the exhaust gas is 212 foot-pounds.

The amount of work required to produce a certain back-pressure reduction can be arrived at by moving the piston, with the exhaust valve open, a certain distance from release position so that when the piston with closed exhaust is brought back into release position, the cylinder content is assumed to have expanded adiabatically from the original pressure to the reduced back pressure. For the foregoing example the reduction of back pressure from 15 lb. abs. to 7.5 lb. abs. represents a work of 12 foot-pounds.

It is therefore evident that, considering energy conditions alone, a back pressure of 7.5 lb. abs. could be produced even if the ejector apparatus had an efficiency of only 6 per cent.

Energy Required

The assumption so far has been that the exhaust is piston controlled or, in other words, that the exhaust port is closed as soon as the low back pressure is produced. In case of counterflow, four-valve unaflow, and four-stroke-cycle internal-combustion engines, the exhaust, however, is kept open during part or the whole of one stroke and additional work would be required to maintain the low pressure in the cylinder in spite of the piston displacing a certain volume. For the example cited, the total work required—that is, work to produce the low pressure of 7.5 lb. abs. and to maintain it in the cylinder up to exhaust closure—amounts to 28 ft.-lb., a figure that also is small as compared with the energy available in the exhaust gases.

It therefore follows that from pure energy considerations the creation of low back pressure by means of exhaust energy must be considered feasible.

Indirect Gain

Besides the direct gain there is an indirect gain to be had from back-pressure reduction, and this indirect gain in most cases outweighs the direct gain. In case of a unaflow engine the indirect gain is produced by the reduction in clearance volume possible. According to the investigations of Professor Stumpf a certain clearance volume brings about a certain volume loss which can be expressed in per cent of the total steam consumption. An engine operating with 25 per cent release, 150 lb. abs. steam pressure and atmospheric exhaust, requires a clearance volume of 8.5 per cent with a corresponding volume loss of 24 per cent. If it is now possible, owing to back-pressure reduction, to cut the clearance volume to 4 per cent, then the volume loss also reduces to 11.5 per cent. The indirect gain, therefore, amounts to 12.5 per cent. This figure is to be compared with 2.28 per cent as representing the direct gain by the back-pressure reduction.

Considering the exhaust phases, the exhaust ejector principle is therefore applicable to the following engine types:

1. Locomotives or other non-condensing engines with cylinders in twin, triple or quadruple arrangement, also three- and four-cylinder compound engines.

2. Two- and four-stroke-cycle internal-combustion engines having four or more cylinders.

Any fluid jet has a tendency to impart velocity to particles immediately surrounding it, and this action can be intensified if the jet is made to enter a coaxial tube. A steady suction effect is produced under the following conditions.

1. The jet must, for a certain distance, completely fill the coaxial tube; the tube, therefore, must not be too short in proportion to its diameter.

2. The nozzle from which the jet issues must not be so close to the tube as to hinder the entrance of the medium to be ejected.

3. To prevent the jet from hitting or impinging on the end of the tube, the nozzle must not be too far away from the mouth of the tube.

Zeuner, in his treatise on the locomotive blast pipe, has proved that if these conditions are fulfilled, a strong ejector action will be obtained irrespective of the relative length of nozzle distance and suction-tube length.

The exhaust period of a cylinder may be subdivided into two parts. The first part comprises the period during which the steam or gas due to its higher pressure exhausts itself; the second part begins at the point when the pressure in the cylinder has fallen to the back pressure and further exhaust takes place due to the action of either the piston or the ejector. The relative amount of steam or gas exhausted during the two parts of the exhaust period is obtained by continuing the expansion line down to back pressure.

The ejector part of the exhaust piping of an engine, therefore, must be arranged in such a way that the steam of every cylinder at times is ejecting or being ejected. It is evident that it is impossible to adhere strictly to conditions herein enumerated.

*Extracted from a treatise by the author.

†Dipl. Engineer, Charlottenburg, Germany.

Water Power Plant To Be Erected in Greece

A convention relative to the execution of works at Peloponnesus for the supply of electricity has been signed between the Minister of Communications and a group of associated French capitalists.

In accordance with this convention, the French concern is obliged to construct three special plants within three years near the waterfalls of Selinous, Krathys and Borraikos in order that the water power be utilized for the production of electricity to the extent of about 57,000 hp. This power will be conducted through cables to Athens and be used for illumination and electric power in the city and the suburbs. The same electric current will also be utilized for the illumination of the cities and villages situated between the three mentioned plants and Athens, according to *Commerce Reports*.

Recent Publications

Mechanical Stoking. By David Brownlie. Published by Isaac Pitman & Sons, New York. Cloth, 4½x6 in.; 234 pages; 122 illustrations. Price, $1.50.

A practical treatise on the essentials of combustion written by an engineer who is in all probability the most widely known authority on combustion in Great Britain. The book is divided into six chapters under the following headings: The history of mechanical stoking, coking stokers for cylindrical boilers; sprinkling stokers, stokers for water-tube boilers, mechanical coal and ash handling, advantages, disadvantages and best methods of working mechanical stokers. Although the book describes principally the stokers in general use in Great Britain and Europe, it contains much valuable information on the principles of mechanical stoking in general.

Oil and Gas Power. By Albert W. Daw and Zacharias W. Daw. Published by D. Van Nostrand Co., New York City. Cloth; 7x11 in.; 460 pages; 232 illustrations. Price, $12.

Students of gas-engine thermodynamics have depended largely on the experiments of Dugald Clerk and his treatise for interpretation of the heat reactions occurring in the engine cylinder. Since Clerk published his work, there has been an immense amount of investigation carried on which has remained hidden from the average engineer. In this new volume on oil and gas power the authors have apparently collected all the really worth-while data of recent origin and are to be congratulated on the discrimination displayed in the choice of the available material. The method of treatment is excellent. Starting out with concise statements of the various laws applying to a perfect gas, the reader is led into a study of the characteristics of ordinary fuels. Typical modern gas- and oil-engine designs are given, together with data as to fuel consumption of the several types. While the gas-engine portion is admirable, the authors failed to maintain the high level of value when dealing with oil engines. This section is extremely weak, due doubtless to the authors' closer acquaintance with the gas engine. The volume is undoubtedly the most valuable treatise on gas engines issued in recent years, and is of value both as a textbook and as a reference.

Line Charts for Engineers. By W. N. Rose, teacher of mathematics at the Borough (London) Polytechnic Institute. Published by E. P. Dutton & Co., New York, 1923. Cloth; 5½x8¾ in.; 95 pages; 47 illustrations; tables of logarithms, sines, tangents, etc. Price, $3.

This book, as one of the "directly useful" engineering series, is admirably suited to the needs of many engineers who desire practical instruction in the construction of computing charts or "nomograms." In point of view of difficulty and mathematical knowledge required, it occupies an intermediate position between Peddles' elementary book on the one hand and on the other the more advanced treatises by Lipka and by Hewes and Seward. The only mathematical knowledge needed for its understanding is a working familiarity with logarithms, the ability to transpose the symbols in such an equation as

$$\frac{a^n b}{c^m} = d$$

a slight acquaintance with trigonometry and the laws of similar geometrical figures. To one who has this minimum foundation, the book will be a remarkably lucid instructor in a subject of great practical value to engineers. After going into the details of scale construction, the author explains the construction of the more common types of collinear diagrams with natural and logarithmic scales, both straight and curved. Each case is illustrated by a practical problem completely worked out. The clarity and conciseness of the presentation particularly adapt this book for home study by busy engineers.

Commercial Utilization of Fuels (Wirtschaftlicke Verwertung der Brennstroffe). Third and enlarged edition, compiled by C. DeGrahl. Published by R. Oldenbourg, Munich and Berlin, Germany. Paper binding; 8x11 in.; 649 pages; 323 illustrations, 16 inserts and 202 tabulations. No price stated.

This book may well be termed an engineering encyclopedia on all fuels, their byproducts and their combustion. It is a very complete treatise on the commercial utilization of fuels from both an economic and an engineering point of view. It contains a great wealth of statistical information that will prove helpful to the industrial engineer as well as to the designer of power, gas and coke-oven plants.

The fuel situation in Germany and the many efforts to combat the existing shortage is the motive behind the labor expended in gathering so much material in a well-presented text.

The volume covers solid, liquid and gaseous fuels. It discusses the preparation, distillation, gasification, extraction and liquefaction of solid fuels and describes a large number of gas-producer and coke-oven designs. The theory of combustion and boiler heat balance are comprehensively treated. Stokers, economizers and accessories to obtain the maximum heat output from inferior coals, turf, baggasse and refuse are described. Oil burners for steam boilers and industrial furnaces are shown with a summation of the advantages and disadvantages of oil firing. In the section devoted to gas burners the recent progress made with flameless combustion is included. Some interesting formulas on heat transmission from the gases to the water in modern steam boilers are given. Boiler operation and control are well presented. Recommendations for the purchase of coal, its classification, care in storage and judicial selection are given. Heating by steam and hot water and a description of a number of heating-boiler designs receive considerable attention.

Some interesting practical data are included in the discussion and comparison of government-operated central stations and private plants of similar capacity, and are particularly directed to conditions where there is a market for the sale of exhaust steam. The chapter devoted to the manufacture of producer and illuminating gas and their distribution is commendable for its completeness and in particular for the practical formula on the friction losses in long pipe lines that it contains. A number of suggestions for converting obsolete power plants into more economical installations are given, and the possible means of improving their load factor by storing energy during the light loads are mentioned.

The concluding chapters deal with the economics of mining coal, the more extensive use of brown coal, pulverized fuel, the utilization of waste heat from stationary and locomotive boilers and the ways of securing more economical use of fuel in heating large buildings and in the home for heating and cooking purposes.

American engineers with a fair knowledge of German can obtain much useful information by reading this book.

Die Kaltemaschine. By M. Hirsch. Published by Julius Springer, Berlin. Cloth; 6x9 in.; 500 pages; 261 illustrations. Price, $4.75.

The refrigerating industry has depended to a great extent upon rules of thumb and practical experience, somewhat to the exclusion of theoretical considerations. The author of this work has attempted, with a considerable degree of success, to collect and interpret the results of tests on refrigerating machines. He has gone into the thermodynamics sufficiently to cover the needs of most engineers. The illustrations cover typical apparatus, and since the greatest development has taken place in America, he has included descriptions and illustrations of many American machines, a thing quite unusual with European authors. Those who read German will find much of interest in this volume, dealing as it does with present day methods.

First General Report of the Lignite Utilization Board of Canada, 1918-1924. The fuel stringency in Canada in 1916-17 necessitated the creation of a board to demonstrate the feasibility of producing a carbonized lignite briquet for domestic consumption. The board has been at work since 1918 making experiments and now reports that the technical problems of making carbonized lignite briquets has been demonstated with full-scale equipment. This report is an exhaustive review of the process and plant. Published by the Lignite Utilization Board of Canada, 188 St. James St., Montreal. Paper; 9 x 6 in. Price, $1.50 after the free circulation is exhausted.

Merchants Against Decrease in Commerce Bureau Budget

Information has reached various organizations to the effect that the House of Representatives is preparing to reduce materially the appropriation for the Federal Bureau of Foreign and Domestic Commerce for the coming year. The Merchant's Association of New York is urging the members of Congress from New York City to support on the floor of the House the amount approved by the Federal Director of the Budget and estimated by the Secretary of Commerce.

Ambrose Swasey Receives John Fritz Medal

One of the highest honors in the engineering profession was conferred upon Ambrose Swasey, of Cleveland, last Wednesday evening through the award of the John Fritz medal in recognition of Mr. Swasey's "achievement as a designer and manufacturer of machines of precision, the builder of great telescopes, a benefactor of education and the founder of Engineering Foundation."

The presentation was made in the Engineering Societies building before a large audience composed of members of the Civil, Mining, Mechanical and Electrical Engineering Societies. Chairman Charles F. Rand referred to the fact that the medal was originally established by the four engineering societies in honor of the great metallurgical engineer, John Fritz, of Bethlehem, Pa. It has since become an international institution, this being the first time in four years that the medal has been awarded in America. He also referred to Mr. Swasey's influence over the furtherance of research in science and engineering, the Engineering Foundation being the first institution to be committed to the management of engineering societies and devoted to their interests.

Addresses were made by Major General Crozier, former Chief of Ordnance, U. S. Army, who told of the work of Mr. Swasey in the design and production of precision range finders, azimuth instruments as used on our sea coast fortifications, panoramic sights and musket telescopic sights so generally used in the late war. General Crozier mentioned numerous instances to show that the exigencies of war had been responsible for the stimulation in design and advance in production in many lines, particularly the metallurgical field.

Dr. W. W. Campbell, Director of the Lick Observatory and President of the University of California, spoke of Mr. Swasey's contribution to the science of astronomy through his work in building the mountings for most of the important telescopes in this country. The first of these was the 36-in. telescope for the Lick Observatory in California, which has been in active service for over 35 years and the mechanism of which is just as good today as when it was first built.

John R. Freeman, of Providence, also a member of the Board of Awards, touched upon the personal side of Mr. Swasey's character and related a number of anecdotes of their trip through the Far East a few years ago.

A.S.M.E. Boiler Code for Czechoslovakia

Word has been received through the United States Department of Commerce that the Czechoslovakia Standards Association is using the A.S.M.E. Boiler Code as a basis in connection with the proposed plan to revise the Czech boiler regulations. Some difficulty has been experienced in reconciling the American boiler-material specifications to European conditions, as the American material specifications have been found too strict. It is reported, however, that this difficulty can undoubtedly be overcome by ameliorating the American specifications for application under those conditions.

A. P. Davis Favors Boulder Canyon Dam

Testifying before the House Committee on Irrigation, A. P. Davis, former director of the Reclamation Service, declared that the Boulder Canyon site is the hub around which all the hydroelectric and irrigation development of the Colorado River should be built. Mr. Davis declared that work at Boulder Canyon could be done at greater speed and less cost than at any other feasible site on the river and that all other developments would fit in with the initial work at this site.

Mr. Davis vigorously opposed the proposals that development of the Colorado River start with a flood-control reservoir at Mohave, asserting that this proposition should be dismissed because it presented what he described as "endless opportunities" for delay and, he asserted, would be "inexcusable from every point."

The topography at Mohave is such that a dam there would be unfeasible for power development; the stored water would be susceptible to evaporation; and the entire project would be more expensive than similar work at Boulder Canyon. Mr. Davis declared that the Mohave site is low, hot, shallow and exposed to wind and therefore is unsuited for water storage.

Forty Diesel Engines Contracted For

The McCurkle Pipe Line, a Dutch Shell company operating in Texas, has just placed orders for forty 400-hp. Diesel engines. Of these Bush-Sulzer Bros. were given contracts for twenty, Worthington Pump & Machinery Co. ten, and McIntosh & Seymour Corp. contracted to deliver ten. These engines will be used in pumping stations of the pipe lines running through Texas.

Dr. Mead's Appointment by Work Meets Approval

The Engineering societies as well as Arthur P. Davis are expressing approval over the appointment of Dr. Elwood Mead, professor of Rural Institutions, University of California, to the commissionership of Reclamation, Department of the Interior by Secretary Work. It is particularly pleasing to the engineers that so brilliant a man as Dr. Mead has been chosen to this position which was so ably filled by Arthur P. Davis and that he meets with the approval of Mr. Davis is also a matter for congratulation.

Dr. Mead has held many important posts in the past, among which are: Territorial and State Engineer of Wyoming; Chief Irrigation and Drainage Investigation, United States Department of Agriculture; chairman, State Rivers and Water Supply Commission, Victoria, Australia; consulting engineer for various irrigation and water-works companies; chairman, California Land Settlement Board. He is a member of the American Civil Engineers and also the Institution of Civil Engineers.

High Dam Power Plant Ready by June

The electric power plant now being constructed by the Ford Motor Co. at the government High Dam between Minneapolis and St. Paul, will be completed in advance of the factory which the Ford company is building adjacent to the development.

Under the terms of the lease of this power to the Ford company by the Federal Power Commission, all surplus energy not used in the new factory is to be delivered to the Northern States Power Co. for distribution in Minneapolis, St. Paul and surrounding territory. Therefore, after the power plant is placed in operation, which is expected to be not later than June, all power developed will be delivered to the company pending the completion of the Ford factory.

The lease also provides for distribution by the Northern States Power Co.

of power in excess of the normal operating requirements of the factory. As the amount of power generated varies with the stream flow, it is impossible to estimate in advance what the excess will be.

Engineers Wanted for Government

The United States Civil Service announces unassembled open competitive examinations for engineers at $3,800 to $5,000, associate engineers $3,000 to $3,600, and assistant engineers at $2,400 to $3,000, to fill vacancies in the Bureau of Standards, Department of Commerce and positions requiring similar qualifications. Applications will be rated as received until July 1. Application blanks, Form 2118, can be obtained from the Civil Service Commission, Washington, D. C., or from the custom houses of the larger cities.

Six Million Dollar Hydro Project for Columbus

The Columbus (Ga.) Electric & Power Co. development on the Chattahoochee River at Bartletts Ferry, sixteen miles from Columbus, which was announced in the Jan. 29 issue of *Power*, has preliminary plans which call for a dam 120 ft. high with provision for an ultimate installation of 60,000 kw. The initial installation is to be two 15,000-kw. units, and the estimated cost of the first development is six million dollars. Stone & Webster, Inc., Boston, Mass., are preparing the plans and specifications and have the general management of the property, and R. M. Harding is local manager of the Columbus company.

Guide Lecturer for London Science Museum

So many engineers intend to be in England this year in connection with the World Power Conference and other meetings that a guide lecturer has been appointed by the Science Museum of the South Kensington, London, to conduct parties daily through the engineering and science collections there.

Now that these facilities exist, a visit should not be missed by those that would like to visit the collection.

The guide lecturer is Eng. Capt. E. C. Smith, O.B.E., R.N. Ret., who is exceptionally well qualified for the duty. Captain Smith is a frequent contributor to *Power*.

Motor Fuel "Natalite" To Be Made in Vancouver

An option has been secured in Vancouver on a site for a plant to manufacture "Natalite," a South African motor fuel, which is half gasoline, the other half having an alcohol base. The promoters claim that this fuel can be produced at a cost allowing successful competition on the market. The "Natalite" will be produced from black-strap molasses or any cheap fermentable body, such as damaged grain, fruit, vegetables, sulphite, liquors, etc. The company expects to begin with an initial output of 2,500,000 gal. per year, requiring approximately 40,000 tons of molasses per annum, according to Consul General Frederick M. Ryder, Vancouver, British Columbia.

Plants Continue To Install Fuel-Oil Equipment

That power-plant executives are confident that there will be a supply of boiler oil sufficient to meet conditions is evidenced by the fact that the Iowa Electric Co. at Guthrie Center, Iowa, the General Electric Co. for its new power house in West Philadelphia, and the Murphy Varnish Co., Newark, N. J., have recently placed orders for the Bethelehem-Dahl fuel-oil-burning apparatus.

Large Impulse Unit To Go in Big Creek No. 1

What is believed to be the largest impulse hydraulic prime mover yet constructed will be installed in Big Creek power house No. 1 of the Southern California Edison Co. during the latter part of 1924. The unit will be built by the Pelton Water Wheel Co., of San Francisco. It will be a double overhung horizontal impulse wheel capable of developing 35,000 hp. under a net effective head of 1,900 ft. This installation is in addition to three previous units of 22,000 hp. each, and will bring the total capacity of the plant up to 99,300 hp. The capacity of Big Creek No. 2 will also be increased by 22,500 hp. through the installation of another wheel of this rating operating under an effective head of 1,780 ft.

One feature of particular interest in connection with the 35,000-hp. unit will be the special design of the lower housings, disk rings and hubs, which will permit of the changing of all parts of the water wheels with a minimum loss of operating time. Replacement of parts can be quickly accomplished or the prime movers may be changed over from a 50-cycle to 60-cycle operation through the use of interchangeable parts which will be supplied.

California First in Hydro Power Production

Discussing hydro-electric power development in California at a recent meeting of the Bankers' Association at San Francisco, W. E. Creed, president of the Pacific Gas & Electric Co., of that city, said that the state produces more electric energy from water power than the combined output of New York, New Jersey and Pennsylvania. During the year just past California had an output of 4,119,275,000 kw.-hr., as compared with 4,099,554,000 kw.-hr. in the three states noted.

In California 94 per cent of families use electric service, it is stated, or an available hydro-electric generating capacity of 2 hp. per family, as against an average for the entire country of 1 hp. per family. Of the total of 11,000,000 consumers of electricity in the United States, California has more than 1,000,000, or one customer for every 3½ persons, while the country in general has but one customer for every 10 persons.

California, it was set forth, has 9 per cent of all of the residence consumers in the nation, 10 per cent of all the commercial consumers, and 15 per cent of all the industrial consumers, with only 3½ per cent of the total population of the United States. The state has 64,000 industrial consumers as compared with 42,600 in Illinois, 30,500 in Pennsylvania, 27,350 in Ohio, and 25,550 in New York.

World Power Conference Social Functions

Engineers To Be Entertained at Luncheons, Dinners and Receptions

Additional attractions are being announced for the World Power Conference which is to be held in Wembley, London, from June 30 to July 12:

Monday, June 30—Formal banquet by officials of Conference to delegates to World Power Conference (delegates are guests, but others are invited on subscription basis).

Thursday, July 3 — United States delegation gives a complimentary banquet to the officials of the Conference.

Friday, July 4 — American dinner, Prime Minister of England and American Ambassador are probable speakers (open to the public by subscription).

Monday, July 7—Dinner to be given by the Institution of Mechanical Engineers for leading foreign mechanical engineers.

Tuesday, July 8 — Reception and lunch given by the Institution of Mechanical Engineers at British Empire Exhibition.

Wednesday, July 9 — Inspection of exhibition with informal luncheon, Institution of Mechanical Engineers. Conversazione, Institution of Civil Engineering in the evening.

Thursday, July 10 — Kelvin Centenary Celebration. 4:30 p.m., Presentation of Kelvin Medal to Dr. Elihu Thomson. 5:00 p.m., Presentation of addresses by delegates from the bodies represented on the Committee of Honor and an "Oration," by Sir J. J. Thompson. 9:00 p.m., Reception of delegates by the President of the Society.

Friday, July 11—6:45 p.m., Kelvin dinner, The Rt. Hon. Earl Balfour in the chair (Connaught Rooms).

Saturday, July 12 — Institution of Electrical Engineers function only. Visit to Cambridge, Reception by the University.

Sunday, July 13 — Joint function. Special service, Westminster Abbey and St. Paul's.

Monday, July 14 — Institution of Electrical Engineers only: Visit to Birmingham, Stratford-on-Avon and Kenilworth Castle.

Tuesday, July 15 — Institution of Electrical Engineers only: Visit to Underground railways; lunch; visit to Windsor Castle. Joint Council Conversazione: Past and present members of the Councils of Civil, Mechanical and Electrical Engineers acting as hosts to foreign visitors, at the Institution of Civil Engineers building.

World Power Conference—Program of Papers

Papers Proposed or Arranged to Date

Australian Commonwealth

Sec. A—"The Power Resources of Australia."

Austria

Sec. A—"The Development and Utilization of Water Power in Austria." Bundesministerium für Handel und Verkehr. "The Coal Resources of Austria." Bundesministerium für Handel und Verkehr. "The Utilization of the Power Resources of Austria, with special reference to the Consumption of Electric Power." Direktor Ing. Eugene Karel. "The Electrification of the Austrian Federal Railways." Ministerialrat Dr. Ing. Arthur Hruschka.

Sec. B—"Recent Practice in Civil Engineering with reference to Water Power Production." Oberbaurat Ing. Karl Innerebner. "Progress in Mechanical Engineering with reference to Power Production." Verband der Deutsch-Oesterr. Maschinenindustrie.

Sec. C—"Complete Gasification of Coal." Prof. Dr. Hugo Strache. "Testing Department for Fuels, Technical College, Vienna." Prof. Dr. Hugo Strache. "Heat Economy in Austria." Gesellschaft für Wärmewirtschaft, Vienna.

Sec. D—"The Reciprocal Utilization of Waste Energy." Oberbaurat Ing. Bernhard Moritz Gerbel, Vizeprasident der Ingenieurkammer.

Sec. G—"Modern Practice in Power Transmission and Distribution in Austria." Direktor Ing. Ludwig Kallir.

Sec. J—"The Austrian Electro-Chemical Industry, with an Appendix upon the new Institute for Technical Electro-Chemistry at the Technical College, Vienna." Prof. Dr. Heinrich Paweck.

Sec. N—"The Influence of Large Water Power Installations on the Regime of Flow." Prof. Dr. Ing. Freidrich Schaffernak. "Divining Measurements by means of the Torsion Balance in Austria." Hofrat Prof. Dr. Richard Schumann. "Electro-Aeronautic Research Work." Generaldirektor Ing. Oskar Taussig. "Health Conditions and Welfare Work in Austria." Sektionsrat Dr. Ernst Brezina and Ministerialrat Dr. Mumelter. "International Cooperation in Technical Work." Ing. Dr. Wilhelm Exner. "Austrian Laboratories for Technical Research and the Testing of Materials." Technisches Versuchsamt im Bundesministerium für Handel und Verkehr. "Rivers as Factors of Energy." Ing. Edward Suess. "Standardization in Austria." Oesterrfichischer Normenausschuss für Industrie und Gewerbe.

Belgium

Sec. A—"Ressources en Energie que renferment les Gites de Combustibles Minéraux de la Belgique." A. Renier. "Production et Consommation d'Energie en Belgique—Bilan calorifique du pays." M. Delmer. "Organisation des Cours d'Eau en Belgique pour la Navigation et la Production d'Energie." Lieutenant-Colonel Fontaine.

Sec. G—"Production et Distribution de l'Énergie Electrique en Belgique." M. Moreau.

British Guiana

Sec. A—"The Water Power Resources of British Guiana."

Dominion of Canada

Sec. A—"National Review of the Power Situation in Canada." J. B. Challies.

Sec. B—"Water Power Production." H. G. Acres.

Sec. D—"Carbo-Power Production." B. F. Haanel.

Sec. G—"Power Transmission and Distribution." Julian C. Smith.

Sec. H—"Utilization of Power." P. T. Davies.

Czechoslovakia

Sec. A—"Review of the Natural Sources of Energy and their Use, in Czechoslovakia."

Denmark

Sec. A—"The Water Power Resources of Denmark." A. Carstensen.

Sec. F—"Utilization of Wind Power in Denmark." (a) "Meteorological data." Prof. E. Schou. (b) "Modern types of Wind Mills." P. Vinding.

Sec. G—"Transmission of Power from Norway to Denmark." A. R. Angelo and Prof. Wm. Rung.

Sec. H—"Technical Development and Financial Organization, including Co-operative Schemes, for Electricity Supply in Denmark." F. H. Krebs. "Technical Development of Low Tension Distribution Lines, and the Execution of House Installations." V. Faaborg Andersen.

Dutch East Indies

Sec. A—"The Water Power Resources of the Dutch East Indies." A. Groothoff. "Fuel Power in the Dutch East Indies." G. J. L. Coninck Westenberg.

Sec. B—"General Principles and Conditions of Water Power Production in the Dutch East Indies." Prof. J. N. Van der Ley. "Special Conditions of Civil Engineering Features of Water Power Development in the Dutch East Indies." W. Blaser.

Sec. G—"General Principles of Power Transmission in the Dutch East Indies; Interlinking of Power Stations." Prof. J. N. Van der Ley. "High Tension Transmission Lines in the Dutch East Indies." W. Nobel.

Sec. K—"Electrification of Railways in the Dutch East Indies." Dr. G. De Gelder.

Sec. M—"Legislation for Electricity Supply in New Countries." Prof. J. N. Van der Ley.

Sec. N—"Electrical Standardization in the Dutch East Indies." C. D. Volker.

Finland

Sec. A—"The Power Resources of Finland."

France

Sec. A—"Inventaire des Resources Hydrauliques de la France." M. de la Brosse. "Régularisation des Cours d'Eau." M. Genissieu. "Electrification du Bassin Houiller du Pas-de-Calais." "Electrification d'une Houillère Moderne." "Inventaire des Ressources Houillères existant en France." M. Guillaume. "Production d'Energie Electrique par l'Utilisation des Gaz de Hauts-Fourneaux et de Fours à Coke." M. Cornu-Thénard.

Sec. G—"Lignes Electriques de Jonction." M. Maroger. "Les Grandes Lignes de Transmission d'Energie Electrique à Très Haute Tension en France." M. J. Tribot Laspière.

Sec. M—"Législation des Forces Hydrauliques en France." M. Arbelot.

Great Britain

Sec. A—"The Coal Resources of the World." Sir Richard Redmayne. "The Physical and Chemical Survey of the National Coal Resources of Great Britain." Dr. C. H. Lander. "Oil Production in its Relation to the Resources and Needs of the British Empire." Sir George Beilby. "A Review of the Water Power Problem in Great Britain and Ireland." Prof. A. H. Gibson. "The National Development of the Water Power Resources of Scotland, and its Relation to Imperial Power Problems." Dr. J. F. Crowley and Eric M. Bergstrom.

Sec. B—"Problems relating to Run-Off, Storage, and the Allocation of Catchment Areas in Great Britain and Ireland." W. J. E. Binnie. "Factors of Efficiency in Hydro-Electric Development." Col. C. M. Norrie.

Sec. C—"The Winning and Utilization of Peat." Prof. Pierce F. Purcell. "The Combustion of Powdered Coal in Cement Rotary Kilns." Dr. C. Martin. "The By-Products of Coal Distillation in Relation to Power Production." W. G. Adam. "Coal Treatment and Carbonization, with Special Reference to Low Temperature Methods." Prof. H. E. Armstrong. "The National Economic Power of Solid Fuel, in Relation to its Scientific Utilization, with Special Reference to Fuel in Pulverized Form." Leonard C. Harvey.

Sec. D—"Steam Generation." Sir James Kemnal. "Steam Turbines." The Hon. Sir. Charles Parsons.

Sec. D—"The Measurement of High Temperature and its Importance in Fuel Economy." Sir Robert Hadfield, Bart. "Coke for Steam Raising." E. W. Nicol. "Fuel Conservation and Smoke Abatement." F. W. Goodenough.

Sec. E—"Internal Combustion Engines." James Richardson. "Gaseous Explosions." Prof. R. V. Wheeler. "The Gas Producer as applied to Large Scale Power Generation." A. H. Lymn. "The Gas Turbine." A. H. Lymn and H. Holzwarth. "Gas Engines."

Sec. G—"The Transmission and Distribution of Electrical Energy." C. H. Merz. "High Voltage D.C. Generation and Distribution of Electrical Energy." J. S. Highfield and W. E. Highfield. "High Voltage Underground Cables." LL.B. Atkinson. "Loading Limits for Electric Power Cables—Some Recent Researches." E. B. Wedmore. "Power Factor Improvement." Prof. Miles Walker. "Large Generators." A. B. Field. "Mechanical and Hydraulic Variable Transmission of Power." Dr. H. S. Hele-Shaw. "Power Transmission and Distribution by Means of Gas." Dr. E. W. Smith.

Sec. H—"Some Notes on the Future of Electrical Supply and Demand." Sir Alexander Kennedy. "Electro-farming Economics." R. Borlase Matthews. "Industrial Use of Gas." Sir. Arthur Duckham. "Science in the Gas Industry—Present, Past and Future." Prof. J. W. Cobb. "The Present Position and Future Prospects of the Gas-Making Industry." D. Milne Watson.

Sec. J—"Electrolytic Iron." T. W. S. Hutchins. "Electrostatic Precipitation." Sir Oliver Lodge.

Sec. K—"Application of Power to Rail Transport." Roger T. Smith and C. B. Collett. "Power Applied to Road Transport." Col. R. E. B. Crompton. "Application of Power to Sea Transport." "Shipowners and Shipbuilders." The Rt. Hon. Viscount Inchcape. "Sail—Its Early History and Later Development." Basil Lubbock. "Steam and the Measurement of Power." Hector C. Bywater. "Hull Resistance and Power for Propulsion." G. S. Baker. "Sea Speeds and their Costs." Alexander Gray. "Fuels and their Supply." F. J. Leathers. "The Development and Present Position of the Motor Ship." A. P. Chalkley. "The Marine Diesel Engine—Its Origin, Development and Future." F. E. Rebbick. "Two-cycle Diesel Engines." Robert Traill. "Diesel Auxiliary Machinery in connection with Marine Propulsion." Richard W. Allen. "Electric Transmission of Power for Propelling Machinery." W. J. Belsey. "Résumé." F. A. Hook. "Application of Power to Air Transport." A. Ogilvie.

Sec. L—"Progress in Electrical Illumination." C. W. Sully, the Electric Lamp Manufacturers' Association of Great Britain. "The National and International Aspects of Illuminating Engineering." L. Gaster. "International Co-Ordination in Illumination." J. W. T. Walsh.

Sec. M—"The Financial Aspect of Hydro-Electric Development." George Balfour, M.P. "The Effect of Depreciated Currencies and International Financial Conditions on Power Development within the British Empire." Sir Ernest Harvey. "Government Coöperation in Power Development within the British Empire." Rt. Hon. Sir Philip Lloyd-Greame, M.P. "The Economics of World Power." Sir Philip Nash.

Sec. N—"Standardization, National and International." C. Le Maistre. "The Education of the Apprentice." Prof. A. P. Lawrie and Prof. F. G. Baily. "The Education and Training of the Engineer of the Future." A. P. M. Fleming. "Broadcasting: The New Influence." J. C. W. Reith. "The Importance of Greater Public Interest in Mechanical Progress." T. C. Elder. "The Place of Publicity in the Public Service of Electricity Supply." J. W. Beauchamp. "Man in Relation to Production." D. R. Wilson. "The Resources of the British Empire in Metals, used in the Manufacture of Machinery." Prof. Henry Louis. "Alcohol as a Source of Power." Sir Charles Bedford. "Some Power Areas in the British Empire, and their Possibilities from the point of view of Industrial Development." R. P. Wilson.

Holland

Sec. A—"Power Resources of the Netherlands." Prof. Ir. F. K. Th. Van Iterson.

Sec. C—"Oil-refining." C. J. M. Milo.

Sec. D—"Steam Turbines for High Pressures." C. F. Stork.

Sec. G—"Application of Squirrel Cage Induction Motors with Special Starting Characteristics." A. Brunt. "Iron Clad Switchgear." H. A. Hidde Nijland. "Recent Developments in Power Station Design in the Netherlands." J. J. L. Smits. "The Electrification of the Netherlands." F. A. Smit Kleine and High-Tension Committee, Vereeniging van Directeuren van Electriciteitsbedrijven in Nederland.

Sec. H—"Development of the Use of Electricity for Domestic Purposes." Dr. W. Lulofs

Sec. K—"Some Considerations on Traction for Railways and Tramways." Prof. Ir. I. Franco. "General Data on the Propulsion of Ocean-Going Ships in Holland." Ir. W. J. Muller.

Sec. L—"Some Modern Points of View concerning the Construction of Electric Incandescent Lamps." Dr. Ing. N. Halbertsma.

Sec. M—"Executive and Administrative Interest by Public Authorities in the Supply of Electricity in the Netherlands." J. G. Bellaar Spruyt and E. A. Schoon.

Sec. N—"Some Notes on Power Stations running in Parallel." Ir. G. J. Th. Bakker and Ir. J. C. Van Staveren. "Considerations as to the most Economical Ratio of Increase in a Series of Standardized Main Dimensions." Dr. Ir. J. Goudriaan. "The Education of the Engineer in the Netherlands and its Colonies." Prof. L. A. Van Royen. "Psychotechnics in the Netherlands." J. L. Prak.

Hungary

Sec. A—"The "Power Resources of Hungary."

Indian Empire

Sec. A—"National Review of the Water Power Resources of the Indian Empire." J. W. Meares. "Water Storage Conditions in India." S. K. Gurtu.

Italy

Sec. A—"General Report on the Water Power Resources of Italy, Developed and Undeveloped (historical, economical, statistical)." Prof. G. Mortara, with the assistance of the 3rd section of the Superior Council of Public Works. "Italian Organization for Collecting Data on Water Power with a General Review of Local Hydrological Features in Relation to Power Generation." Prof. G. De Marchi, with the assistance of the Hydrographic Survey of the Ministry of Public Works. "The Production of Hydro-Electric Energy as a National Problem." Ing. Angelo Omodeo.

Sec. B—"Recent Developments in Dam Construction in Italy." Ing. L. Mangiagalli. "Recent Developments in Italian Water Turbines." Ing. Ucelli. "The Continuity and Regularity of Operation of Large Electric Systems." Ing. Guido Sememza. "The Coexistence of Hydro-Electric and Steam-Driven Generating Stations as affecting the Economy of Production and the Necessities of Storage and Reserve." Prof. G. Motta.

Sec. E—"Large Internal Combustion Engines." Ing. G. Tosi. "Internal Combustion Engines for Motor Transport and Aviation." Sen. G. F. Agnelli.

Sec. F—"The Larderello Natural Steam Plant." Prince Piero Ginori Conti.

Sec. G—"Recent Electrical Developments in Overhead Transmission Lines." Ing. U. Del Buono. "Recent Mechanical Developments in Overhead Transmission Lines." Prof. G. Rebora. "The Limits of Extension in the Parallel Operation of Electric Systems with special reference to Economy and Service." Ing. R. Norsa. "Electric Cables for Extra High Tensions." Ing. L. Emanueli.

Sec. K—"Electric Traction in Italy." Prof. Ing. F. Tajani. "Electro-Metallurgy in Italy." Prof. F. Giolitti.

Japan

Sec. A—"The Power Resources of Japan."

Dominion of New Zealand

Sec. A—"The Water Power Resources of New Zealand.

Norway

Sec. A—"Hydrography of Norway." O. Rogstad. "Water Power Resources of Norway, Developed and Undeveloped." I. Kristensen. "Cost of Developing Water Power." S. Kloumann. "The Coal Fields of Spitzbergen and Bear Island." A. Hoel.

Sec. B—"Electrical Supply of the City and Peninsula of Bergen." Asbj. Bjerke and E. Monsen. "Electrical Supply of Christiania." R. Steen. "Ice Troubles in Norwegian Rivers." A. Ruths.

Sec. G—"Determination of Efficiency and Phase Displacement in Transformers by Measurement on Open Circuit and Short Circuit" Prof. O. S. Bragstad. "The Influence of Voltage Regulation on Electricity as a Product of Quality. Proposal for International Rules of Voltage Regulation." Prof. Fr. Jacobsen.

Sec. H—"Electrical Power in Norwegian Households." J. Sandberg. "Electricity Rates in Norway." Joh. A. Haga.

Sec. J—"Nitrogen Fixation." Dr. B. F. Halvorsen.

Sec. K—"Railway Electrification in Norway." H. Schreiner.

Sec. M—"Export of Electrical Power." S. Kloumann. "Synopsis of Norwegian Water Power and Electricity Acts." H. Larsen. "The Financing of Loans for Power Development." M. Stuevold-Hansen.

Section N.—"Proposal for Uniform Rules for Testing Water Power Plants." Prof. G. Sundby. "Desirability of Standardizing Electrical Household Appliances." H. Grosch.

Poland

Sec. A—"Economic Situation and Power Resources of Poland."

Russia

Sec. A—"Power Resources of Russia (Coal, Naphtha, Water Power and Forests)." "Utilization of the Resources of Russia." "Production, Transmission and Distribution of Electrical Energy."

Southern Rhodesia

Sec. A—"Review of the Water Power Resources of Southern Rhodesia." C. L. Robertson. "The Coal Resources of Southern Rhodesia." H. B. Maufe.

Spain

Sec. A—"National Review of Water Power in Spain." Pedro M. González Quijano. "Hydraulic Regime of several Spanish Rivers." Carlos Mendoza. "Canalization and Utilization of Water Power in the Guadalquivir between Cordoba and Seville." Carlos Mendoza.

Sec. B — "Characteristics and Brief Description of the Scheme for Developing Hydraulic Power from two important groups of Water-falls in the Basin of the Duero." José Orbegozo. "Elimination of Vegetable Matter carried in the Canal Water." Cornelio Arellano. "Elimination of Mineral Matter carried in the Canal Water." Cornelio Arellano. "Canals on Sloping Ground." Emilio Arazola. "Some Features of Modern Hydro-Electric Developments." Diego Mayoral.

Sec. G—"Network of National High Tension Lines." Luis Sanchez Cuervo. "Description of the System of Generating, Transmitting and Distributing Electricity in Catalonia." Catalana de Gás y Electricidad S. A. "Considerations affecting the Interconnection of Existing Transmission Systems." Claudius E. Bennett.

Sweden

Sec. A—"The Power Resources of Sweden." F. V. Hansen.

Sec. B—"General Conditions of Water Power Development in Sweden." A. Ekwall. "Recent Practice in Swedish Water Power Engineering." A. Westerlind. "Recent Practice in Lake Storage and what the Storage means to Water Power Utilization in Sweden." Gottfried Berg. "Measures taken in Sweden against Ice Troubles in Water Power Plant." A. Frey Samsioe. "Recent Swedish Arch Dam Design." Bo Hellstrom. "Modern Tendencies in Water-Wheel Design." Prof. Hj. O. Dahl. "Planning of Hydro-Electric Plants, with regard to Reliable Operation." K. E. Nylander.

Sec. C—"Preparation of Fuels in Sweden." Dr. A. F. Enstrom. "Saw-Mill Waste as a Fuel." Otto Nordstrom. "Power from the Wood Waste of the Swedish Forests." Dr. H. von Eckermann. "A New System of Oil Production from Swedish Oil Shale." S. P. Bergh.

Sec. D—"Outstanding Features of Swedish Practice in Steam Power Production." H. Lundberg. "Some Points with reference to Combustion Economy." O. Rodhe. "Steam Generation at Extra High Pressures." I. V. Blomquist. "High Pressure Water Tube Boilers." O. A. Wiberg. "Steam Accumulation." Dr. J. Ruths. "Recent Development in the Construction of Steam Turbines." O. A. Wiberg. "Extra High Pressure Steam Turbines." P. Nordstrom. "Air Pre-Heating." Fr. Ljungstrom.

Sec. E—"Review of Internal Combustion Engine Development in Sweden." Prof. E. Hubendick. "Diesel Engines." K. J. E. Hesselman. "Hot-Bulb and High-Compression Engines." G. Dillner. "Carburetter Engines." Prof. E. Hubendick. "Gas Engines." Prof. E. Hubendick.

Sec. G—"Recent Developments in A.C. Generator Design." R. Liljeblad. "Recent Practice in Transformer Construction." K. E. Eriksson. "Economic and Technical Organization of Large-Scale Power Distribution" W. Borgquist. "Technical and Administrative Systems for Rural Electrification in Sweden." N. Ekwall. "Low Tension Distribution and Electric Storage." C. Rossander. "Design and Standardization of Transformers." A. Ytterberg.

Sec. H—"Power Saving Through Anti-Friction Bearings." Uno Forsberg. "Electricity in Agriculture." N. Ekwall.

Sec. J—"The Electro-Chemical Industry in Sweden." Prof. W. Palmaer. "A New Resistance Furnace with Reaction Zone." T. Holmgren.

Sec. K—"Power Problems of the Swedish Railways." I. Ofverholm. "Power Questions relating to Swedish Tramways." A. Hultquist. "Power for Water Transport in Sweden." H. Hammar. "The Reversing-Clutch Marine Turbine." O. A. Wiberg.

Sec. M—"Power Policy." C. Kleman.

Sec. N—"Organization of Research Work in Sweden." Dr. A. F. Enström. "Industrial Standardization in Sweden." A. Kruse. "Elementary Engineering Education." N. Fredriksson. "Advanced Engineering Education." H. M. Pleijel. "Education for Commerce." Prof. C. Hallendorf.

Switzerland

Sec. A—"The Power Resources of Switzerland."

Sec. G—"High Voltage Power Transmission.

Sec. H—"Power in Agriculture." "Domestic Uses of Power."

Sec. K—"Railway Electrification."

Union of South Africa

Sec. A—"The Power Resources of the Union of South Africa."

United States of America

Sec. A—"General National Review of Power Resources, Distribution and Utilization." O. C. Merrill, N. C. Grover and M. R. Campbell. "Regional Review for Northern Eastern States, with particular reference to New Uses for Energy, New Methods of Application and Relative Costs, and Expanding Markets and Delivery." John W. Lieb. "Similar Regional Review for Central and Southern States." Samuel Insull. "Similar Regional Review for Pacific States." John B. Miller.

Sec. B—"General Review of Current Practice in Water Power Production." John R. Freeman. "Relation of Power Development and Irrigation upon the same Streams." Henry J. Pierce. "Power Development on Navigable Rivers." Hugh L. Cooper. "The Design and Construction of High Dams." A. P. Davis. "The Design of Water-Wheels and Controlling Equipment."

Sec. C—"Preparation of Fuels." C. F. Hirshfeld.

Sec. D—"General Review of Current Practice." Col. Peter Junkersfeld and Geo. A. Orrok. "Boilers." D. S. Jacobus. "Steam Turbines." W. L. R. Emmet. "High Pressure and Superheat." W. S. Monroe.

Sec. E—"Present Status of Internal-Combustion Engine in America." Dr. Charles F. Lucke.

Sec. G—"Power Station Electrical Equipment." B. G. Lamme. "The Technical Problems of High Tension Electric Power Transmission." F. G. Baum. "Economics of Power Development in Large Stations Interconnected into a Single Super-Power System." W. S. Murray.

Sec. H—"Electric Power in Steel Mill Operation." B. H. Shover. "Electric Power in the Textile Industry." Charles T. Main. "Electric Power in the Paper Industry." H. H. White.

Sec. J—"General Review of Electro-Chemical Progress and Processes in the United States." F. C. Fitzgerald. "Electric Power in Metallurgy." Frederick Laist.

Sec. K—"Railroad Electrification." Bion J. Arnold. "Electric Ship Propulsion." Commander Robinson, U.S.N.

Sec. M — "Government Policies Best Adapted to Promote Power Development." Hon. Herbert Hoover. "Private v. Public Ownership and Operation." Arthur T. Hadley. "Financing of Power Development in the United States." S. Z. Mitchell. "Relation of Power Development to Industrial and Economic Progress." Guy E. Tripp. "Power Development from the International Standpoint." Owen D. Young. "Policy and Practice in the United States in the Future Regulation of Public Utilities." Carl D. Jackson.

Sec. N—"New Fields for the Development, Distribution and Utilization of Power in which Research should be vigorously Conducted." E. W. Rice, Jr. "International Standardization in the Field of Power." S. W. Stratton. **"The Social Aspect of Power Development."** F. R. Low. A Paper by Julius Barnes.

Personal Mention

George C. McGowan, engineer, has been appointed managing director of the B. C. Valve Co., Ltd., Vancouver, B. C.

James Link, formerly chief engineer of the Knoxville, Tenn., Power & Light Co., has been appointed superintendent of the electrical department of the company.

R. B. Harlan has resigned his position as power-plant superintendent of the Ridgway plant of the West Penn Co. to take up his former position with the American Engineering Co.

Verner J. Swanson, formerly instructor of mechanical drawing, mathematics and shop theory at the Hampton Institute, Va., has joined the A. L. Powell Power Co., Inc., Cleveland, Ohio, as chief engineer.

H. W. Dickinson, the Honorary Secretary of the Newcomen Society for the study of engineering and technology, who was over here on a visit last spring, has been promoted to be a keeper in the Science Museum, South Kensington, London.

Obituary

Peter H. Bullock, former chief engineer of the Massachusetts Reformatory, died on April 18 at his home, 115 Commonwealth Ave., Concord Junction, Mass., in his seventy-fifth year. He was born in Grafton, N. H., and entered the railroad shops at Concord, N. H., when he was 16 years old. He became installation engineer of the Boston Machine Co. and later was appointed chief engineer of the old state prison at Concord Junction, retiring from this position May 15, 1922. He was a member of Corinthian Lodge of Masons and a past-president of the Engineer's Blue Room Club, of Boston. Beside a widow he leaves two daughters.

Society Affairs

The Boston Section of the A.S.M.E. and of the **M.I.T.** will have Dr. Charles Lucke of Columbia University as the speaker for its May 6 meeting. "Oil Engines" will be the subject.

The Weymouth Power Station of Boston, Mass., during its construction will be recorded in a moving picture entitled "Power," which will be available for distribution this fall, without rental charges. It can be obtained from Stone & Webster, Inc., 147 Milk Street, Boston.

The Central Pennsylvania Section of the A.S.M.E. will hold its Spring meeting at Williamsport, Pa., on May 3. Visits to industrial plants of Williamsport will be made in the morning, luncheon at the Lycoming Hotel and the afternoon devoted to professional papers. George Orrok will present a paper on some modern phases of power-plant design and operation, and Thomas Midgley, Jr., will deal with modern development in automobile fuels.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual meeting at San Francisco, June 11-13.

American Boiler Manufacturers' Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Annual meeting at the "Homestead," Hot Springs, Va. June 9-11.

American Order of Steam Engineers. W. S. Wetzler, 753 North 44th St., Philadelphia, Pa. Annual meeting at Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 9-13.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Kansas City, Mo., June 10-12.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at Cleveland, Ohio, May 27-29.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio. Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Illinois Association** at Rockford, Ill., June 4-6. L. G. Schlemm, 805½ South Ninth St., Springfield, Ill. **Indiana Association** at Lafayette, Ind., May 5-6. Prof. A. W. Cole, Purdue University, Lafayette, Ind. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio.

The National Board of Boiler and Pressure Vessel Inspectors. C. O. Myers, 502 Comstock Bldg., Columbus, Ohio. Annual meeting at Cleveland Hotel, Cleveland, Ohio, May 26-29.

National District Heating Association. D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 10-12, 1924, formerly announced June 11-14.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section.** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Hotel Statler, Buffalo, N. Y., April 30 to May 2, 1924.

Smoke Prevention Association. Frank A. Chambers, 111 North Dearborn St., Chicago, Ill. Eighteenth annual convention at Hotel Statler, Buffalo, N. Y., June 3-5.

Stoker Manufacturers Association. G. A. Sacchi, Westinghouse Elec. & Manufacturing Co., Philadelphia, Pa. Annual meeting at Edgewater Beach Hotel, Chicago, Ill., June 2-4.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

The Chamber of Commerce of the United States will have a session devoted to "Natural Resources" at its May 6-8 meeting to be held at Cleveland. James R. Garfield will speak on the subject of "Government Control of Natural Resources"; Goldwaithe H. Dorr on "Trade Association Problems Relating to Natural Resource Industries."

Business Notes

The Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York City, announces the removal of its Chicago office on May 1 to No. 9 South Clinton St.

The Northern Equipment Co., Erie, Pa., announces that H. V. Brown, formerly with the Copes Feed Water Regulator, has been appointed as its district representative for eastern Kentucky and the southwestern portion of West Virginia, with headquarters at Huntington, W. Va.

The Brady Conveyors Corp., 20 West Jackson Boulevard, Chicago, Ill., has announced the appointment of the Walter S. Dickson Co., 90 West St., New York City, as its district sales representative and the appointment of E. J. Fettig, 610 Bearinger Building, Saginaw, Mich., as its Michigan representative.

Trade Catalogs

Engines, Una-Flow—Mesta Machine Co., Pittsburgh, Pa. Bulletin U-1 shows the results of recent tests of Mesta unaflow engines built under Stumpf patents and has illustrations of various installations.

Combustion—The Engineer Co., 17 Battery Place, New York City. Bulletin "A Message on Combustion," describes the Turner baffle walls, oil burning equipment, and Enco balanced draft system of this company.

Purifier, Steam—Andrews-Bradshaw Co., 530 Fourth Ave., Pittsburgh, Pa. Bulletin No. 26 "Why Steam is Impure?" tells of the many impurities contained in steam and the merits of the Tracy Steam Purifier.

Petroleum — Tide Water Oil Sales Corp., 11 Broadway, New York City. "An Unusual History of Petroleum," gives an interesting and humorous account of oil from ten million years ago up to today, in twelve installments.

Sawing, Cold — The Earle Gear & Machine Co., 4707 Stenton Ave., Wayne Junction, Philadelphia, Pa. Booklet "Economy in Cold Sawing," describes with illustrations of installations, the Lea Simplex cold cutting-off saws.

Thermometer, Industrial—The Motor Meter Co., Inc., Long Island City. "Motoco Industrial Thermometer," is the title of a well gotten up catalog describing this dial-face indicating thermometer made of non-ferrous metal, which is not affected by atmosphere and which can be used in pipes of small diameters. Dial ranges and price lists of thermometers with both capillary tubing and rigid stem are given.

Metal Coating—Metals Coating Co. of America, 495 North Third St., Philadelphia, Pa. Pamphlet, "Meta Layer-Schoop Process," describes the process of coating metals for protection against high temperatures and corrosion. It is well illustrated and covers the subject thoroughly.

Power Plants, Industrial—Lockwood, Greene & Co., Engineers, 24 Federal St., Boston. Booklet telling of phases of design of industrial power plants as distinguished from the design of central-station power plants. Photos illustrate the kinds of plants handled by this company.

Preheated Air, Boiler Tests with—Combustion Engineering Corp., Broad St., New York City. This pamphlet is an abstract of a paper presented by C. W. E. Clarke of the Dwight P. Robinson & Co., Inc., at the annual meeting of the A.S.M.E. in New York in December. The paper is based on tests made at the Colfax station of the Duquesne Light Co. and is well illustrated with curves. A copy may be obtained free, by writing the Combustion Engineering Co.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Apr. 14, 1924	Apr. 21, 1924
Pool 1	New York	$3.25	$3.00
Smokeless	Columbus	2.35	2.35
Clearfield	Boston	2.50	2.40
Somerset	Boston	2.70	2.50
Kanawha	Columbus	1.75	....
Hocking	Columbus	1.75	1.75
Pittsburgh No. 8	Cleveland	1.85	1.85
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.90	1.75
S. E. Ky.	Louisville	2.00	1.75
Big Seam	Birmingham	2.25	2.25

FUEL OIL

New York—April 24, light oil, tank-car lots, 28@34 deg. Baumé, 5½c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—April 12, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2 per bbl.; 32@36 deg., gas oil, 5½c. per gal.; 38@40 deg., 6½c. per gal.

Pittsburgh—April 14, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 5⅞c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—April 18, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—April 17, 28@30 deg., $2.415@$2.478 per bbl.; 18@22 deg., $2.10@$2.16½; 13@16 deg., $1.785@$1.848 per bbl.

Boston—April 15, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4⅝c. per gal., light oil, 28@32 deg. Baumé, 6⅝c. per gal.

New Plant Construction

Ala., Loachapoka—The Mills Lumber Co., Eufaula, Ala., W. W. Hicks, president, plans for the construction of a steam power house at its proposed local lumber mill, estimated to cost $45,000.

Calif., Los Angeles—Weber Showcase & Fixture Co. has started operations on a one-story factory to cost $300,000, which will include two 100-hp. boilers and a dust collection system. Hamm & Grant, Inc., 607 Ferguson Bldg., Los Angeles, are engineers for the plant.

Calif., Redwood City—Bids will soon be asked by the Board of City Trustees for a deep well pump for the municipal waterworks. C. L. Dimmitt is city engineer.

Calif., Riverside—The Southern Sierras Power Co. plans for the construction of a hydro-electric power plant at Levining Creek, reported to cost about $175,000. Extensions will also be made in the generating station at Blythe, Calif., including the installation of a generator and auxiliary equipment.

Calif., San Francisco—The Constructing Quartermaster, Fort Mason, will soon ask for bids for the installation of nine centrifugal pumps and accessory apparatus for deep wells at Lobos Creek, on which drilling is being completed.

Calif., Stockton—Eugene Graham, county clerk, will receive bids until May 6, for one turbine pump for deep well service, as per specifications on file.

Colo., Longmont—The City which owns its own hydro-electric plant will erect as an auxiliary a 600-hp. Diesel type engine to take care of a 350 kw. generator as a standby. Bids will be asked on May 6. The present hydro-turbine takes care of about 500 kw.

Fla., Center Hill — R. L. Carpenter, chairman of the purchasing committee of the common council, has inquiries out for one 75 g.p.m. deep-well pump, motor-driven, direct-connected, with transformer; one 60,000 gal. capacity steel tank on 100 ft. steel tower; pipe, valves and accessory equipment for waterworks service.

Fla., Hollywood — The Hollywood Electric Light & Power Co. plans for the erection of an addition to its local steam-operated power plant, with the installation of a new engine (probably Diesel type) and auxiliary equipment. C. B. Moody is superintendent.

Iowa, Des Moines—The Des Moines Electric Co., Eight and Locust Sts., has awarded a general building contract to Arthur H. Neumann & Co., Hubbell Bldg., for the erection of its proposed steam-operated electric generating station on local site, to be two-story and basement, 114 x 400 ft. and 60 x 400 ft., estimated to cost $5,000,000, with equipment. It is expected to place orders for equipment in the near future. M. G. Linn is general manager.

La., New Orleans—G. A. Peters, 630 Audubon Bldg., is making inquiries for a 300-hp. water-tube boiler and auxiliary equipment.

Md., Baltimore — The Department of Public Works, Bureau of Water, City Hall, George H. Biles, director, will take bids until May 6, for mechanical equipment for the water system, including safety devices for pumping stations, contract No. 670; duplex strainers, contract No. 671; auxiliary heating coils, contract No. 672; sand-washing machines, contract No. 674; engine cylinders, contract No. 675; water meter parts, contract No. 677; single nozzle, contract No. 679; and 6, 8 and 12-in. stop valves, contract No. 680. Full information on file at Room 796, City Hall.

Mass., Boston—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until May 6, for 6 motors, complete with controllers and spare parts for the local navy yard, as specified in Schedule 2096.

Mass., Cambridge—The Ford Motor Co., Highland Park, Detroit, Mich., is said to be arranging an early call for bids for the erection of its proposed local assembling works, with steam power plant, estimated to cost $500,000. Albert Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mich., Caro—The W. N. Clark Canning Co. has commenced extensions and improvements in its plant, to include the installation of additional engines, boilers and accessory apparatus at the power house. The project will include a 100 ft. brick stack.

Minn., Herman—G. I. Haney, village recorder, will receive bids until May 5, for pumping equipment for waterworks service, as per specifications on file at the local office, or that of Corey & LeCocq, Aberdeen, S. D., engineers.

Mo., Marshall—Bids are being asked (no closing date announced) by the Board of Public Works, C. D. Alexander, clerk, for condensers and stokers for the municipal power station. The Henrici-Lowry Engineering Co., Commerce Bldg., Kansas City, Mo., is engineer.

Mo., St. Louis—The W. H. Lampe Shoe Co., 4000 Forest Park Boulevard is planning for the rebuilding of the portion of its boiler plant and factory recently destroyed by fire with loss reported at $38,000, including equipment.

Neb., Kearney—Bids will be received by Mrs. M. E. Burke, city clerk, until May 7, for equipment for the municipal waterworks, including power house building, well houses; two 300-hp. oil engine units, switchboard and transformer; three horizontal motor-driven pumps; cast iron pipe, all as per plans and specifications at the office of the Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., engineer.

N. J., Princeton—The Board of Trustees, Princeton University, has authorized the construction of a boiler plant on site near the Baker Memorial Skating Rink, for which plans have been prepared. It will be equipped to use oil fuel.

N. J., Trenton—The Thomas Maddock's Sons Co., Perry St., has asked bids on a general contract for the erection of its proposed sanitary ware manufacturing plant on site recently purchased in Hamilton Township, near Trenton, to include a steam-operated power house, estimated to cost in excess of $500,000. W. E. S. Dyer, Land Title Bldg., Philadelphia, Pa., is engineer.

N. Y., New York—H. E. Verran Co. are to build a processing artificial silk plant. A one-story boiler house is included in the plans. Longwood, Greene & Co., 24 Federal St., Boston, Mass., are the engineers in charge.

New Zealand, Wellington — The Public Works Tenders Board will receive bids until July 29, for equipment for the power plant, Lake Coleridge Power Scheme, Section 146, including two turbines complete with governors, etc.; spare parts and tools. Also, other generating equipment, with spare set of field brush-holders and brushes, etc., all as specified in Tender No. S. M. 186, available at office noted.

N. C., Raleigh—The Board of Trustees, North Carolina State College of Agriculture and Engineering, has awarded a building contract to J. A. Gardner, Charlotte, N. C., for a new power plant at the institution, on which work will be commenced at once. A list of equipment to be installed has been arranged. J. E. Sirrine & Co., Greenville, S. C., are architects and engineers.

N. C., Rockingham—Steele's Mills, Inc., will soon break ground for the construction of a new boiler plant, in connection with a number of other buildings at its textile plant. Robert W. Porter is president and treasurer.

Ohio, Columbus—The W. M. Ritter Lumber Co. is planning for the purchase of a Corliss engine for installation at its plant, about 28 x 48 in.

Ohio, Toledo—The Toledo Edison Co. is planning for extensions in its Acme power plant to increase the capacity to 125,000 kw. The boiler department will be provided with additional water-tube boilers and accessory equipment for about 6,000 hp. additional output. The expansion is estimated to cost $1,000,000. A. K. Young is manager.

Pa., Aspinwall—The United States Veterans Bureau, Room 791 Arlington Bldg., Washington, D. C., will take bids until May 20, for a boiler house, steel water tower and tank, septic tanks and house, with refrigerating plant, smoke stack, etc., at the proposed local hospital, as per plans and specifications on file. Frank T. Hines is director.

Pa., Greensburg—The Board of Directors, School District of Greensburg Borough, City Hall, will receive bids until May 13, for a mechanical split system of heating and ventilating, ash-handling equipment and coal storage bins for the local high school. Plans and specifications at the office of Maurice E. Kressly & Co., Harrisburg, Pa., architects.

Pa., Easton—The City Ice Co. is reported to be planning for extensions and improvements in the local ice-manufacturing plant of the Merchants' Ice Co., recently acquired.

Pa., Greenville — The Mercer County Heat, Light & Power Co. has tentative plans under advisement for extensions and improvements including additional equipment, in its steam-operated power plant.

Pa., Philadelphia—The Breyer Ice Cream Co., Cumberland and Eighth Sts., plans for the installation of an ice and refrigerating plant at its proposed six-story works at Woodland Ave. and Forty-third St., to cost in excess of $125,000. The W. F. Koelle Co., Twenty-eighth St. and Oxford Ave., is architect.

Pa., Philadelphia—The Department of Public Health, Room 564, City Hall, Dr. Wilmer Krusen, director, is taking bids until May 2, for the construction of an addition to the power house at the Byberry City Farms, in connection with other buildings at the institution. Philip H. Johnson, 1713 Sansom St., is architect.

Pa., Philadelphia—The Philadelphia Lumbermen's Exchange, Crozier Bldg., and other local lumber interests, plan for the construction of a steam-operated electric power plant at their proposed lumber terminal and milling plant on Oregon Ave., estimated to cost $15,000,000. Wilson H. Lear, president of the Exchange, is head of the committee in charge.

Pa., Philadelphia—The Viscose Co., Marcus Hook, Pa., plans for the construction of a steam-operated power plant at its proposed artificial silk mill on site just acquired at Talcony and Shelmire Sts., aggregating 6 acres, estimated to cost in excess of $500,000.

Pa., Red Lion — Officials of the local Board of Trade contemplate the construction of a steam power house at a proposed local chair manufacturing plant, for which a company is being organized to carry out the project, capitalized at $200,000.

Pa., Williamstown—The Pottsville Electric Co. has acquired the local electric light and power plant, and will make extensions and improvements in the station. Headquarters are at Pottsville, Pa.

Portugal, Oporto—The Municipal Council has appointed a commission of three engineers to study slaughterhouse apparatus and refrigerating plants to be installed in the new municipal abattoir. Catalogues and covering letters should be addressed to "The American Consul, Oporto, Portugal."

S. C., Aiken—The Carolina Light & Power Co. has tentative plans under consideration for the construction of a hydroelectric power plant at the Croft mill site, lately acquired.

S. C., Charleston—The Ashley Ice Cream Co., 576 Meeting St., has plans under way for the installation of refrigerating and cold storage equipment at its plant. J. H. Heinson, Jr., is secretary.

S. C., Cowpens—The Common Council is considering the installation of electric-operated pumping equipment at the proposed waterworks and sewerage plants, for which a special election has been called on May 13 to vote bonds for $75,000.

S. C., Pageland—The Pageland Cotton Mill, recently organized with a capital of $250,000, plans for the construction of a steam power plant at its proposed local textile mills, to cost in excess of $100,000. J. O. Taylor is president.

S. D., Virgil—The Town Clerk will receive bids until May 2, for equipment for a waterworks, including one 250 g.p.m. centrifugal pump, direct-connected to oil engine; 30,000-gal. elevated steel tank on tower; pipe, etc., as per plans and specifications at the office of Smith & Reeves, Western National Bank Bldg., Mitchell, S. D., engineers.

Tenn., Caswell—The Southern Railway Co., Washington, D. C., will construct a refrigerating plant at its new freight yards and shops at Caswell, near Knoxville. A power house will also be built. The entire project will involve close to $1,250,000. Work will soon be commenced.

Tenn., Jackson—The City Council plans for the installation of electric-operated pumping equipment in connection with proposed extensions in the municipal waterworks, for which a special election will be held on May 1 to vote bonds for $150,000.

Tenn., Memphis—The E. L. Bruce Co. is considering the construction of a steam-operated power house at its proposed lumber mill on 20-acre timber tract recently purchased, estimated to cost $115,000.

Tenn., Memphis—The Memphis Power & Light Co. has sold a bond issue of $1,000,000, a portion of the fund to be used for expansion in generating plants, including the installation of a 20,000 kw. generating unit and auxiliary equipment at the local station, on which work is in progress. T. H. Tutwiler is president.

Tex., Beckville — The American Stave Mfg. Corp., New Orleans, La., plans for the construction of a steam power plant at its proposed local lumber mill on large tract of land, recently acquired, estimated to cost $100,000, with equipment.

Tex., Colorado—The Anderson-Prichard Oil Co., Oklahoma City, Okla., plans for the construction of a pumping plant in connection with a pipe line to a proposed local oil refining works. A power house will be built at the refinery. The entire project will involve close to $400,000. J. S. Anderson is vice-president.

Tex., East Dallas—The Ford Motor Co., Highland Park, Detroit, Mich., is perfecting plans for the early erection of a one-story power plant, 65 x 70 ft., at its proposed local assembling works at East Grand and Henderson Aves., estimated to cost close to $1,000,000, with machinery. Albert Kahn, Marquette Bldg., Detroit, is architect.

Tex., El Paso—The Newburger Cotton Co., Inc., Memphis, Tenn., plans for the construction of a steam power plant at its proposed local cotton compress and fumigating plant, estimated to cost $200,000. Joseph Newburger is president.

Tex., Houston—Under the direction of the local Chamber of Commerce, plans are being arranged for the erection of a cotton mill, with boiler plant, on local site, estimated to cost $500,000. A company is being organized with William A. Mitchell as head. A site has been acquired on East Montgomery Road.

Tex., Italy—The Italy Oil Mill Co. is reported to be planning for the construction of a boiler plant in connection with the proposed rebuilding of its mill recently destroyed by fire with loss of about $80,000.

Tex., Luling — The Lone Star Ice Co. plans for the immediate erection of a one-story ice-manufacturing plant to cost approximately $32,000.

Tex., Nacogdoches—The Texas Power & Light Co. has negotiations under way for the purchase of the municipal electric power plant, and proposes to develop for central station service.

Tex., Ralls—The Common Council plans for the installation of electric-operated pumping equipment in connection with the proposed municipal waterworks, for which a bond issue of $50,000, is being arranged.

Tex., Sherman—The Sherman Compress Co. plans for the construction of a steam power plant at its proposed cotton compressing works, 275 x 350 ft., to replace a plant recently destroyed by fire. C. G. Comegys is treasurer.

Vt., Rutland—The Rutland Fire Clay Co. is said to be planning for the construction of a steam-operated power house at its proposed three-story mill, 50 x 120 ft., estimated to cost in excess of $80,000, with equipment.

Va., Bedford—The Bedford Tire & Rubber Co. is said to be planning for the construction of a boiler plant at its proposed local rubber mill, for which work will be commenced at an early date. It will cost about $100,000. A. K. Simmons, Roanoke, Va., is architect. L. R. Gills is president.

Va., Chincoteague Island — Daniel J. Whealton has tentative plans in progress for the construction of an ice-manufacturing plant to replace a works recently destroyed by fire. It is also proposed to construct a boiler house at his new local cooperage plant, to replace the factory likewise destroyed by fire. The project will involve close to $90,000.

Va., Franklin—The Camp Mfg. Co. has inquiries out for a Corliss engine, about 900 hp. and other steam power equipment and lumber machinery to replace the equipment at its mill recently destroyed by fire with loss estimate at $300,000, including buildings.

Va., Lynchburg — C. H. Bell, Ashley, Ohio, is arranging for the organization of a company to construct and operate an ice-manufacturing plant at Lynchburg. It is said that a site has been purchased at Pierce and Fifth Sts., and that plans will be drawn at once for the initial building, to be equipped for a capacity of 100 tons daily.

Va., Norfolk—The Ford Motor Co., Highland Park, Detroit, Mich., is perfecting plans for the early erection of its proposed local assembling plant, with steam-operated power station, estimated to cost about $400,000. Albert Kahn, Marquette Bldg., Detroit, is architect.

Va., Norfolk—The Powhatan Super-Cord Tire Corp., recently organized with a capital of $1,000,000, plans for the construction of a steam power plant at its proposed local rubber mill, to cost approximately $200,000. G. William Land is president.

Va., Norfolk—The Supply Officer, Navy Yard, has been authorized to purchase one coal conveyor belt, as specified in requisition 716, at the local office.

Va., Richlands—The Richlands Ice Co., recently organized, has acquired a local building and will remodel for a ice-manufacturing plant. A list of equipment to be installed for an initial daily output of 10,000 lbs., will soon be prepared. A. A. Underwood is president.

Va., Shawsville—The Shawsville Light & Power Co., recently organized, is planning for the construction of a steam-operated power house. The Matthews Engineering Co., 10 East Church Ave., Roanoke, Va., is in charge. G. W. Gardner is president, and J. R. Sisson, secretary.

Va., Webster—The Webster Brick & Tile Co., P. O. Box 375, Roanoke, Va., recently organized, plans for the construction of a steam power plant at its proposed local works for the manufacture of brick, tile, etc. O. H. Gish is president.

Wash., Aberdeen — The Grays Harbor Railway & Light Co. is perfecting plans for additions in its local steam-operated electric power plant to develop an increase of about 8,000 hp., with installation to include turbine, boilers, pumps and auxiliary equipment.

Wash., Longview — Charles C. Garland, Tacoma, Wash., engineer, has plans in preparation for the construction of a hydroelectric power plant on local site on the Toutle River, estimated to cost $3,500,000. It is understood that a company is being formed to operate the plant.

Wash., Longview — The Pacific Strawboard & Paper Co. plans for the construction of a steam-operated power plant at its proposed local mills, estimated to cost $300,000, with machinery.

Wash., Omak—Charles Ragsdale is planning for the installation of an electric-operated pumping plant at Loon Lake. Application for permission has been made to the state water department.

Wash., Port Angeles—The Northern Pacific Public Service Co. plans for the installation of electric-operated pumping equipment in connection with proposed waterworks development from Morse Creek, estimated to cost $125,000.

Wash., Yakima—The Yakima County Horticultural Union has tentative plans under advisement for the construction of a three-story cold storage plant at A and First Sts., 50 x 180 ft., to cost in excess of $75,000, with equipment.

W. Va., St. Marys—The Common Council contemplates the installation of electric-operated pumping machinery in connection with proposed extensions and improvements in the waterworks, for which bonds for $60,000, will be arranged. J. M. Rice is engineer.

Wis., Allouez (P. O. Superior)—A special election has been called on April 29, to vote bonds for $75,000, for a municipal waterworks and system, with electric-operated pumping equipment.

Wis., New Holstein—The Village Council, Louis Hipke, clerk, plans for the installation of electric-operated pumping equipment in connection with its proposed sewerage disposal plant and system. The Jerry Donahue Engineering Co., 608 North Eighth St., Sheboygan, Wis., is engineer.

Wis., Rhinelander—The Common Council is arranging a bond issue of $150,000 for extensions in the municipal waterworks, including the installation of electric-operated pumping equipment.